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Purse Seines and Other Roundhaul Nets in California

By W. L. SCOFIELD

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CONTENTS

	Page
Foreword	5
Origin of Roundhauls	7
Kinds of Roundhauls	8
Roundhaul Defined	8
Purse Seine	9
Lampara	10
Ringnet	11
Bait Net	13
Definitions	13
Net Operation	13
Gear	13
Net	13
Seine	14
Brailing	14
Set	14
Scouting	14
Turntable	15
Scare	15
Outrigger Pole	16
Christmas Tree	16
Net Construction	17
Net Size and Fishing Depth	17
Webbing	18
Knot	18
Mesh	20
Selvage	21
Twine Size	21
Hanging	23
Cork and Leadline	24
Stapling	24
Bag and Wing	25
Purse	25
Breast Line and Davit Loop	26
Early History of Roundhauls in California	26
First Canneries and First Purse Seine	26
Early Purse Seine Fleet at San Pedro	27
Early Purse Seines at Monterey	28
Lampara Period	28
Second Purse Seine Period	30
Development of Ringnets	32
Purse Seine versus Lampara for Sardines	33
Summary of History	34
Brief Description of Early Nets	34
Monterey Lampara 1922	34
Lampara at San Pedro 1921	35
San Pedro Purse Seines 1922	36
Ringnets 1930	38
Modern Roundhauls	39
General Remarks	39
A Purse Seine Haul	39
Variations	40
Preservation of Nets	40
Period of Large Purse Seines	41
Shares	42
Direction of Layout	44
Skiffs	44
Floats	44

CONTENTS—Continued

	Page
Recent Developments	45
Influences on Fishing Effort	45
Tapered End and Landing Bag	45
Wire Purse Lines	46
Spring Shackle	47
Cork Pursing	47
Zipper	52
Power Pulling	54
Purse Ring Slip Knot	55
Powered Skiffs	55
Refrigeration	57
Brailing	57
Two Nets	60
Chain Leadline and Purse Bridles	60
Depth Finder and Radio Telephone	61
Strainers and Aprons	61
Aerial Scouting	62
Floating Lights	62
Powered Net Pullers	62
Sardine Purse Seines	63
Description of a Sardine Purse Seine	63
Strip Plan	63
Selvage	64
Breast of Net	65
Floats	65
Cork Purse Lines	67
Purse Cable	67
Foot Chain	67
Hanging	69
Chafing Gear	69
Description of Other Seines	69
Tuna Purse Seines	73
White Sea Bass Purse Seines	74
Ringnets	74
Bait Nets	75
Legislation	78
References	81

FOREWORD

The construction and operation of roundhaul nets in this State have been observed and described by various staff members of the Bureau of Marine Fisheries during the past 30 years but nearly all of our published material is now out of print. This bulletin attempts to summarize the history and development of these nets in California and to describe the numerous improvements which have occurred since any of us last published on the subject. Most of the following pages were prepared for publication from 1949 to 1951.

We are indebted to innumerable fishermen for assistance. These men, be they Dalmatian, Sicilian, mainland Italian, Portuguese, Scandinavian, Japanese, Scotchmen or of third generation American stock, were willing to answer patiently questions concerning their trade. They are specialists and proud of their calling. We thank them.

W. L. Scofield
June, 1951

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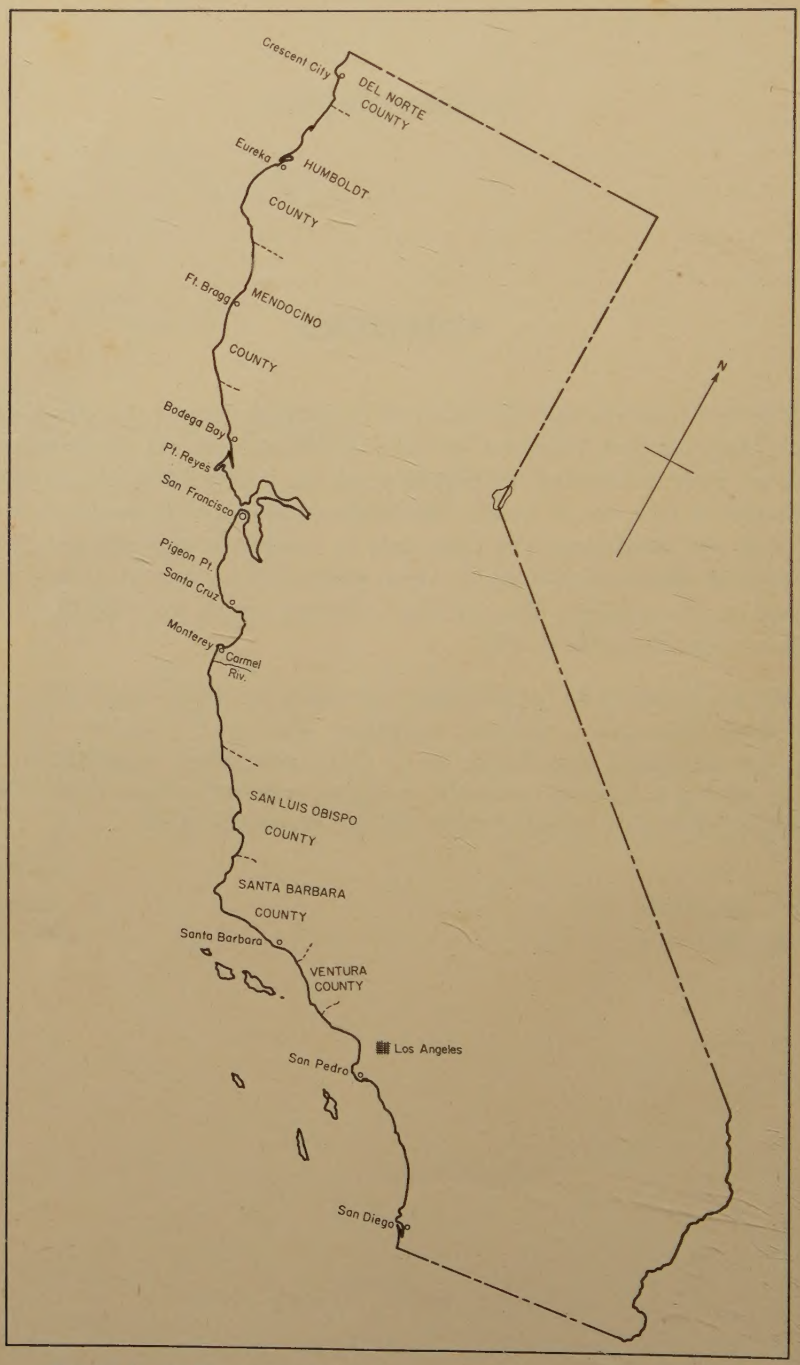

FIGURE 1. Outline map of California, showing location of fishing ports.

PURSE SEINES AND OTHER ROUNDHAUL NETS IN CALIFORNIA

By W. L. Scofield
Bureau of Marine Fisheries

ORIGIN OF ROUNDHAULS

It is probable that fishing was practiced before the development of primitive agriculture. At any rate, there were fishing nets before the first recorded history so that their origin is lost. The prehistoric lake dwellers of Central Europe used nets, and Chinese writings of 1122 B. C. refer to fishing nets. Early Egyptian hieroglyphics (3500 B. C.) picture a net-maker's needle which closely resembles the present day tool and which has not been improved upon in the last five or six thousand years.

What form of net evolved first is not known but certainly the beach seine is a very ancient type. This seine is a simple wall of webbing laid out parallel to the shore or in a semicircle from the shore and then both ends pulled simultaneously onto the beach. The lower edge scrapes the bottom in shallow water and when the two ends are ashore, the fish are impounded. Further pulling onto the shelving beach brings the fish out of the water. The sand or mud bottom in shallow water serves as the floor of this impounding device. In deep water the fish would dive under the seine and escape. Adding fullness of webbing in the middle of the seine (bunt, bag, sack or belly) helps to impound those fishes that enter the bag but there is nothing to stop them from leaving again if the seine is in deep water. Success of this net depends upon shallow water and a beach. In large bodies of water the area that could be beach seined was pitifully small so our ancestors tried hauling the seine into a boat but the fish escaped under the lower edge of the net and under the boat as the two wings were being pulled aboard. A deep bag had been developed for beach seines as illustrated by the Mediterranean "chinchola" seine used in California. It is possible that this suggested making the seine into a large bag with short wings so that it could be at least partially closed while the leadline was being pulled. This large bag with leadline pulled quickly in advance of the corkline is the principle used in the "lampara" type of net. It seems likely that this form of partial closing of the bottom was tried out long before the development of the drawstring or pursing idea. It is probable therefore that the lampara type of net was the next stage in development from the beach seine. The pursing of the net bottom seems to have been a relatively late development.

The pursing to close the net bottom before pulling the net on board a boat is said to have originated in 1826 in the Rhode Island menhaden fishery of our Atlantic Coast (Deblois 1881). That was only 125 years ago. It would seem likely that someone had used the pursing principle to close the net bottom before 1826 but apparently no record was kept if such a method was used. This 1826 menhaden net was 65 fathoms long. Similar purse nets were used by Gloucester fishermen for menhaden and mackerel

in the waters of Maine as early as 1857 and a purse seine was patented on March 12, 1859 by Berent Vedeler of Bergen, Norway. The purse seine was in general use on our Atlantic Coast by 1860, and by 1870, or a little later, the Gloucester mackerel fishermen were using large purse seines, said to be 250 fathoms long. Similar nets are said to have been introduced into Scandinavian countries (into Norway in 1878) from New England and the use of purse seines has spread since to most of the countries of the world. Some Puget Sound fishermen credit the independent discovery of the purse seine to a Chinese of that region about 1887. He may have applied something he had seen long before in his homeland for all too frequently an historical account of "firsts" is found to start with China. At any rate, these seines were used in the Northwest for salmon, herring and later for sardines.

KINDS OF ROUNDHAULS

ROUNDHAUL DEFINED

Roundhaul is a general term applied to long wall-like seines that are laid out in a circle around a school of fish in deep water. The two ends of the net are brought together, the opening at the bottom is at least partially closed to impound the school and the net is then pulled aboard a boat. Under the general classification of roundhaul are included the lampara, purse seine, ringnet, half ring, purse-lampara, most bait nets and the three variations no longer used in California, namely the Japanese shizuoka and its Chinese and Italian counterparts.

Roundhaul does not include a gill net laid out in a circle. The gill net so used is sometimes called a circle net but it is not closed at the bottom. It is not pulled aboard the boat as a unit, and it entangles rather than impounds the fish. However, we have had instances of a deep gill net used to encircle a school of fish (usually white sea bass) and the net is then pulled aboard the fishing vessel. The net so used ceases to be an entangling gill net and becomes an impounding roundhaul net. Failure to close the bottom of the net completely allows some escapement of fish but this inefficiency of gear does not alter its roundhaul feature. When this same net is laid out around a school which is impounded by pulling the seine onto a beach instead of onto a boat, the net becomes a beach seine. In these cases the manner of use determines the type of gear rather than the construction of the net itself. There are other instances of this principle of manner of use rather than construction determining gear.

Round lift nets such as are used for bait or crabs are occasionally called circle nets but are in no sense roundhauls. The term circle net is sometimes applied to roundhall nets but this usage is not common and, for clarity, might better be dropped.

Roundhaul nets are of two basic types, the lampara and purse. There have been variations and modifications which at one time or another have been given a variety of names. This has given the appearance of complexity but the confusion has been more in the names than in the gear. To clear away unnecessary names it is best to consider roundhauls as the two types, purse and lampara with a third, the ringnet, which began as a hybrid between the two but has now evolved into a form closely resembling the purse seine.

The use of roundhaul nets is confined to fishes that school and in the past their operation was limited to schools that could be detected at or near the surface. In recent years with echo depth finders fishermen have been able to detect deeper schools that give no surface indication of their presence. In California, roundhauls in the past have been used for taking barracuda, white sea bass, yellowtail, several of the tunas, mackerel, and sardines. Under present state law, sardines, mackerel, tuna, anchovies and squid are taken in roundhauls. Farther north on this coast, roundhauls have been used extensively for herring, sardines and salmon but in this State purse seines have not been successful in taking salmon and in any event have been illegal for salmon ever since their first use in other fisheries.

PURSE SEINE

A purse seine is a long wall of webbing without prominent bunt or bag, that is, with very little fullness and with the webbing hanging nearly straight down between the cork and leadlines. The main body of the webbing usually is of uniform mesh size. After circling, the seine is pulled aboard from one end only so that the fish are concentrated in the other end. The essential feature of this net is the pursing by pulling a drawstring (purse line) which is threaded through a series of rings along the bottom of the net below the leadline so that the leadline is bunched or puckered. This closes the bottom of the net and completely impounds the catch before the crew begins to pull in the net aboard the fishing boat.

FIGURE 2. A California purse seine boat. Skiff riding the stacked net on after deck turntable. Photograph by Vernon M. Hadden.

LAMPARA

The lampara has a large central bunt and relatively short wings of larger mesh. The two wings are pulled simultaneously. The hanging of the net allows the leadline to be pulled somewhat in advance of the cork-line and this coupled with the rapid pulling of the wings tends to close the net bottom and the net itself assumes a scoop-like shape. There is no pursing device other than the closing of the leadline as the net is pulled. The essential features are then, a large central bunt, wings pulled together, graduated mesh sizes and no purse line or rings. In each of these features the lampara differs radically from the purse seine which is characterized by no bunt, one wing pulled, uniform mesh and use of the purse line with rings.

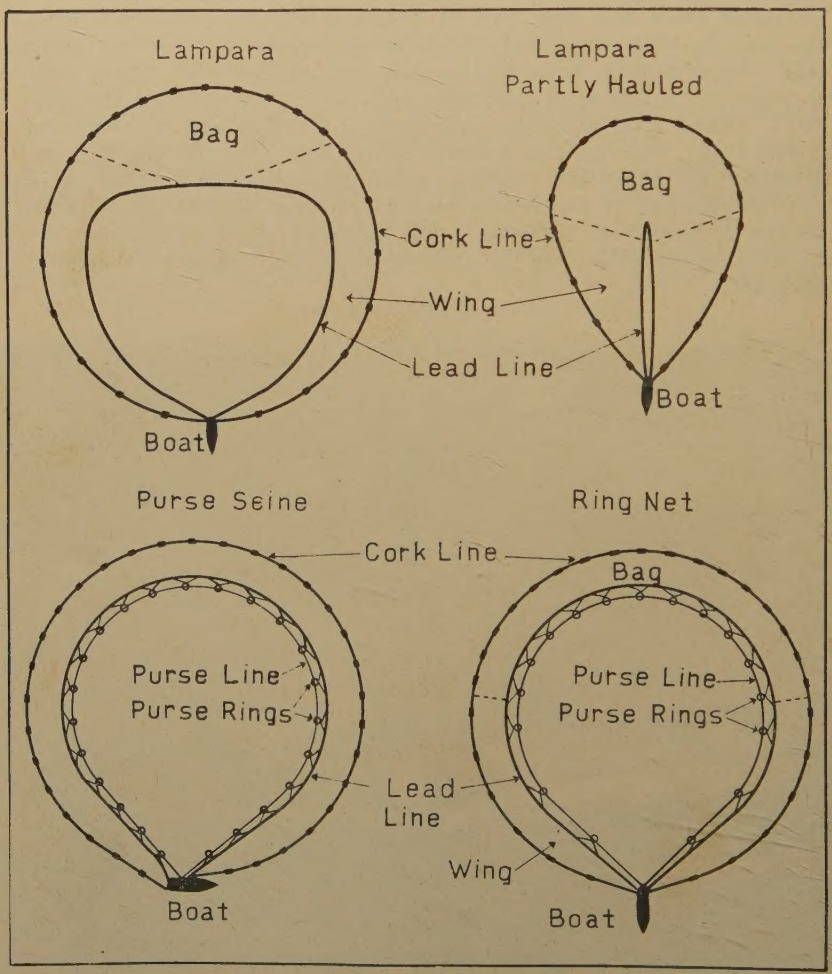

FIGURE 3. Diagram to show lampara, purse seine, and ringnet just before hauling. Upper right corner is a lampara partly hauled. D. H. Fry, Jr., 1931.

RINGNET

The ringnet is a hybrid which started as a modified lampara. It evolved toward the purse seine which it now closely resembles except that the two wings of a ringnet are pulled simultaneously thus confining the fish in the center instead of at one end of the net. (See history of ringnet.) Ringnets have purse rings around the whole leadline. The modern ringnet resembles the lampara and differs from the purse seine in that the two wings are pulled together. It differs from the lampara and resembles the purse seine in that it has purse rings and little or no bunt.

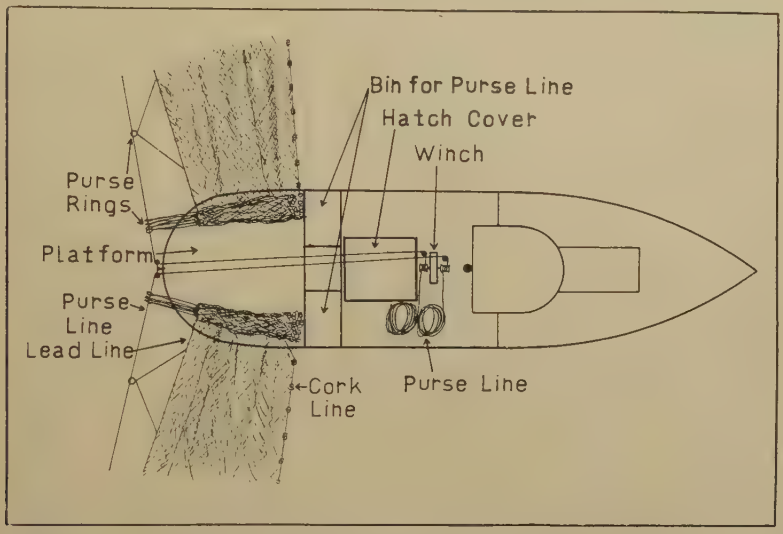

FIGURE 4. Diagram to show pursing and hauling the two wings of a ringnet. D. H. Fry, Jr., 1931.

FIGURE 5. Ringnet pursed and partly hauled by hand pulling. Photograph by Richard S. Croker. December, 1931.

FIGURE 6. Purse seiners at San Pedro. Photograph by Vernon M. Hadden.

Half ring was a term employed when purse rings were placed only half way round the leadline. This practice of half ringing is almost a thing of the past but an occasional net so equipped is still (1949) to be found, usually fishing for bait or for the fresh fish markets. Some older fishermen continue to call their ringnets "half rings" but terminology would be clarified if use of the term half ring were dropped. Some young men who started fishing after lamparas had become scarce, mistakenly call their ringnets "lamparas." Purse-lampara was a term used in the past for half ring but this name is almost extinct, as is the true half ring net.

BAIT NET

Bait usually is taken in roundhaul nets that are smaller than those used in supplying the canning plants. The bait nets are in most cases lamparas without purse rings. Some are small ringnets, often miscalled "half rings" by the operator although a true half ring net may be found only as a surviving oddity. A purse seine bait net is exceptional. These roundhauls (usually lamparas or ringnets) are generally from one-third to three-quarters the size of their big brothers that fish for the canneries. The bait nets catch small fish alive for holding and sale to sport fishermen or to supply live bait to barges and sport party boat operators. Quantities of dead bait are taken for sport and commercial trolling. Many commercial fishing boats, as well as the tuna "bait boats," carry one or more small nets to catch bait for their own use only. Some of the bait catches are delivered to be salted for future bait and some are ground for chum. A few boats operate medium sized roundhauls to supply the local fresh fish markets, or even deliver to the small canneries. This is not bait fishing but these smaller nets are classed with the bait nets.

DEFINITIONS

NET OPERATION

Gear

Gear means many things but applied to fishing it indicates tools, implements or appliances. For most fishing a boat is an essential part of the equipment and in a broad sense gear may be used to include the boat and the fish catching devices aboard. More frequently the term gear is applied to the devices alone, exclusive of the boat, so we speak of a fisherman's "boat and gear."

Net

A net is essentially a knotted fabric as opposed to woven, braided or plaited material. A little girl accurately defined it when she said "a net is a lot of holes tied together with pieces of string." Our two words net and knot are related and the basic idea of a net is the knotting together of cords to form a fabric of uniform openings or meshes. Fishing net is a general term for such a fabric complete and ready for use in catching fish. Fishing nets may either impound or entangle the fish, depending upon their construction and the methods used in operating them. This report is concerned only with one class of impounding nets—roundhauls.

Seine

Seine is an inclusive term applied to movable nets that are long curtains or walls of webbing equipped with floats along the upper edge and weights along the lower margin. Seines are used to impound fish, that is, to confine them in a smaller area where they may be more easily captured. In most cases this means enclosing the fish with the wall of webbing and dragging them up to the shore or to a boat. If pulled up on a beach, the net is a beach seine and when pulled aboard a fishing boat the seines are called roundhauls. Similar nets that are stationary are not called seines.

Brailing

Dipping or ladling fish out of the net into the fishing boat or from the boat to the cannery or market dock is called brailing. The proper word is bailing but the corrupted form spelled with an "r" is in such common use along the California coast that we accept the "r." What is one letter between friends? The long-handled dip net is a "brail." The pouch is of cotton webbing hung from a large metal hoop. The dip nets used for loading the boat are power lifted and the fish dumped into the hold through the hoop. In unloading the boat a different dip net is used, in which the fish is dumped through the far end of the pouch by releasing a small purse line threaded through rings. (Figures 26, 27 and 28.)

Set

Circling a school of fish while paying out the net is said to be "making a set." From the time of circling till the catch is aboard and the net is picked up, the boat (or captain or net) is "in a set." The boat, captain or net are said to set on a school. Paying out the net is commonly called laying out and the completed circle may be called a layout. Impounding a school is frequently called "wrapping." The fish are wrapped and the boat may be "in a wrap," that is, in a set. The old terms "shooting the net" or the "gear was shot" are heard only occasionally.

After the net has been circled and pursed, part of the net is pulled aboard which is called hauling, pulling, strapping in or picking up. The impounded fish in the portion of the net remaining in the water are wrapped, sacked or dried up. The complete operation from layout to pickup may be called a haul, set, or wrap.

Scouting

Usually scouting means the time spent cruising about looking for a school of fish. The term is used also for the operation of looking a school over before setting the net. This preliminary survey is to determine the kind and size of fish, size of the school and direction and speed of movement of the fish as well as to inspect the relationship of water currents to wind as influencing the layout of the net.

In daylight scouting, a school is located by seeing a dark mass of fish in the water, by the flipping of fish at the surface, by rising bubbles or by birds feeding on the school. Nearly all sardine and mackerel seining is done at night when luminescent light caused by the movement of the fish can be seen readily. Luminescence is often called "fire"

or "lights" by fishermen. In recent years the use of a sonic depth finder has aided both daylight and dark scouting to such an extent that it is now considered as standard equipment aboard most of the larger fishing vessels. The use of airplanes to locate schools of fish has been tried intermittently during the past 32 years with partial success only.

Turntable

The turntable, occupying the stern deck of the purse seine vessel, is a platform upon which the seine is stacked. The table is approximately square, 12 to 20 feet on a side, depending upon the size of the vessel's afterdeck. The table can be revolved, on a central pivot, to starboard or to port. On the stern edge of the table in normal position may be a roller one foot or more in diameter over which the seine could be pulled aboard. (Figures 13 and 14.) For a period of years this roller was powered to help in hauling in the seine. When hand pulling was replaced by power hoisting of the net, the roller of the turntable was no longer powered. This was soon followed by the practice of reversing ends of the platform before stacking the net by giving the table a half turn. As a result the roller was no longer of much use and in the more recently built platforms it has been eliminated. Reversing ends of the table permits net stacking with less handling than by the older method. The bunched purse rings are stowed at the starboard rail when first landed on deck and they may be lined up easily on the starboard edge of the platform during net stacking. As the corkline is hoisted in it requires less handling if it is piled in the closest spot, which is on the port edge of the platform. When stacking is completed the table is revolved to normal position, thus bringing the corkline to starboard and the purse rings along the port edge of the turntable, the most convenient position from which to shoot the net at the next layout.

Scare

While a lampara is being pulled aboard a vessel there is an opening left between the wings and under the boat through which fish may escape the net. In ringnets and purse seines there is a similar opening of escape while the two ends of the net are being closed and during the time required to close the bottom of the net by pursing. To prevent this loss of fish from the net, a scare is operated over the side of the vessel in the escape area. A primitive type, still in use, is a weight on the end of a line along which wooden paddles are attached so that they disturb the water and frighten back the fish when the line is jerked up and down in the water. A later device was to put an air pressure hose over the side, from which a cloud of air bubbles spurted and frightened the fish away. A still later improvement was the suspending over the side of a submerged water-tight electric light that could be switched on and off rapidly. This was especially effective when used to supplement the older type plunger after the first end of the net had been recovered and before pursing. The light lowered to a depth of 30 fathoms or more keeps fish away from the open ends of the net and helps in preventing them from sounding till pursing is completed. Flashing light scares were in use in 1930 and probably much earlier.

Outrigger Pole

When the catch is "dried up" in the landing bag ready for brailing, the skiff parallels the vessel with the bag between the two. The weight of the fish in the net tends to pull the skiff alongside the vessel, leaving insufficient space for brailing. To prevent this, a long pole from the vessel has its tip made fast on the skiff. This is called a stand-off stick, or outrigger pole. This is hinged at its base to the rail abreast the mast so that it can be lowered outward and later swung up alongside the mast out of the way. It is installed on the port side for a counter clockwise layout. This device is mistakenly credited with being a recent improvement of about 1930. The first purse seiner in the State, the *Alpha*, used such a pole more than 50 years ago. Even the lampara boats of more than 30 years ago employed a stand-off pole, sometimes two, at the bow and stern of the lighter, corresponding to the seiner's skiff. It is reported that early seining in other regions employed a double pole with cross slats like a ladder to enable crew members to climb back and forth between vessel and skiff.

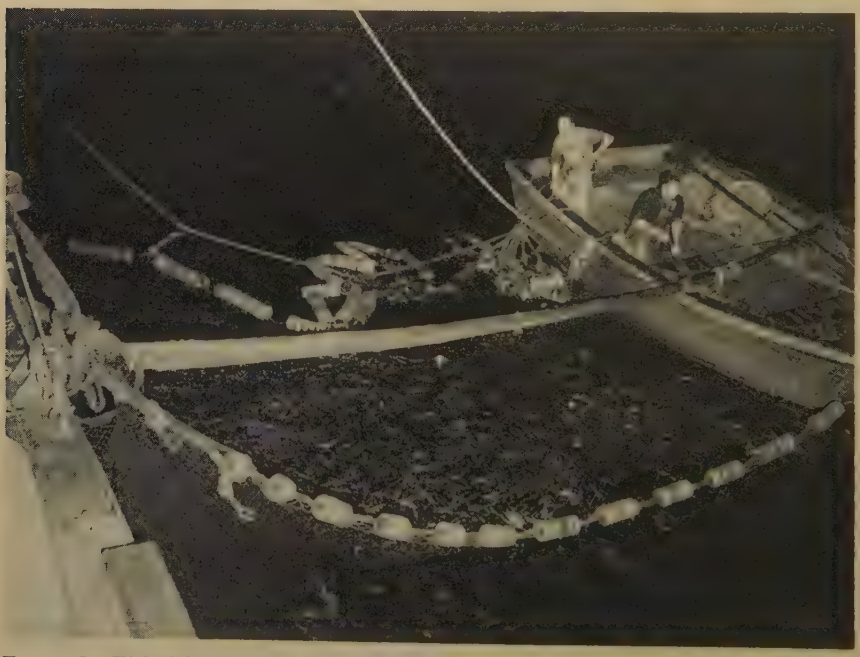

FIGURE 7. Fish dried up in the landing bag of the purse seine. About ready for brailing. Outrigger stick lashed to skiff. Corks are bunched. Night photograph by J. B. Phillips. September, 1945.

Christmas Tree

Sometimes a net is laid out around fish a little too small for the size mesh being used in the net. The unfortunate result is that large numbers of fish (anchovies or very small sardines) are gilled and cannot be shaken out of the net. Sometimes the dead weight of gilled fish is enough to split the seine. Picking out fish by hand would be almost impossible. Boiling the net in a vat or cooking the fish out with a steam hose is about the only

remedy. When a portion of the net is lifted to the boom head, the spreading webbing on deck suggests a tapering conifer tree and the silvery gilled fish suggest tree ornaments, hence the descriptive nickname "Christmas tree." This implies no yuletide joy for it usually means the loss of one or two nights fishing and a consequent financial loss to the crew.

NET CONSTRUCTION

Net Size and Fishing Depth

For judging the size of roundhaul nets the most convenient standard of comparison is the distance (in fathoms) around the corkline. The actual length of the webbing strips making up the net will be greater than the measurement along the corkline because there is take-up when hanging-in the webbing to the corkline. The amount of take-up is variable; also the ratio of leadline to corkline. The leadline is usually shorter than the corkline by 5 to 12 percent.

Net depth is often quoted but this can be approximated only. Depth is affected by the amount of take-up in hanging the net. It is to a great degree dependent upon the shape assumed by the meshes. The meshes of a net hang not as horizontal squares but as diamond shaped openings. When the meshes are partly closed horizontally the net appears shallow. The same net may appear deep a few minutes later if the meshes are pulled partly closed vertically. If the meshes are all completely open the depth of net may be measured on land but this is not the fishing depth because the meshes seldom hang completely open. The theoretical depth of a net when meshes are squarely open may be computed by taking one-half the mesh size (bar measure) times 1.4 inches and multiplying by the number of vertical meshes in the net. This is the same as seven-tenths of the stretched measure of a mesh multiplied by the number of meshes. A similar calculation would be necessary for each selvage strip if of a different mesh size. Finally a total would be obtained but it would not be the fishing depth. A rough rule of thumb for purse seiners and ringnets is that depth is one-tenth of the length of the corkline but this rule is of little help because more nets depart from the rule than comply with it. Fishermen speak of a net as so many meshes deep. This means something as a comparative figure if you know the mesh size and depth of selvage strips. About the only depth figure readily obtainable is a measure of the net laid out on land with the meshes approximately open. The error of measurement is great and the figure obtained is not the fishing depth. The actual fishing depth of roundhaul nets is seldom known even to the fishermen. There have been cases (especially with bait nets) where a net has been hauled in water so shallow that the leadline lightly brushed over the sea bottom. A sounding at this point gave the fishing depth of that particular net at that time. Later when the net had been rehung it might not fish at just that depth. The variation in fishing depth with hanging is even more pronounced in the lampara type of net than in purse seines.

In summary, the over-all size of roundhauls is best expressed as length of corkline. The reader is cautioned to accept statements of depth with mental reservations, remembering that they are approximations and seldom if ever indicate exact fishing depth.

Webbing

Literally, webbing is woven stuff and when used in connection with fishing nets it is a convenient term to designate the knotted cord fabric of the net exclusive of lacings, ropes, floats and other accessories. Our fishermen commonly refer to it as "web" and they frequently use the term "mesh" or "mash" instead of webbing. Practically all webbing used in California is machine woven, usually of cotton twine and is purchased in long strips rolled into bales, from which the fisherman builds his own net. Very few of our nets are ready-made. Occasionally a reinforcing portion of a net is of hand woven webbing.

The standard knot used in making the webbing is shown enlarged and loosened in the center of Figure 8. It is obvious that a vertical pull would tighten the cords of the knot. This is what is called a pull "with the knots." A pull horizontally, called a pull "against the knots" would tend to loosen the knots. Webbing that is subjected to the continued strain of a pull against the knots does not wear as well as though hung to take the strain with the knots. The long strips of machine woven webbing have the knots arranged as in Figure 8 so that the pull with the knots would be across the strip. In making up a net, fishermen hang the cut pieces of webbing so that the greatest strains will fall "across the strip," that is, with the knots. In roundhaul nets there is the horizontal strain of pulling in the net but there is the greater vertical strain of pursing and holding the catch while brailing. The strips of webbing are therefore in most cases hung horizontally along the net so that the vertical strain will fall across the strip "with the knots." In a few roundhaul nets the webbing strips are hung vertically in that portion of the net subjected to the heaviest horizontal pulling strain.

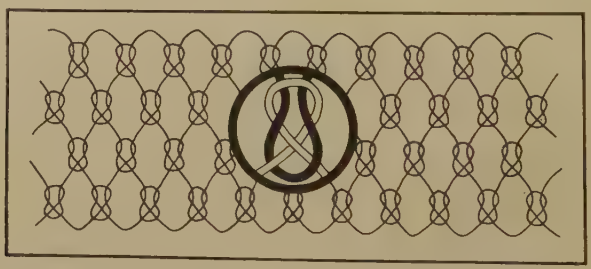

FIGURE 8. Diagram of a narrow strip of webbing with knots loosened. A vertical pull across the strip would be "with the knots."

Knot

The knot used in weaving a fishing net is variously called fishermen's knot, standard knot, mesh knot, sheet bend, trawler's knot, or single becket bend. These knots are distinguished by the purpose for which they are used rather than any essential difference in the way they are tied. Actually the net maker's knot is a bowline although it might be considered nautical heresy to say so. It is made in four different ways. In Figure 9, showing the four aspects of the knot, B. is a back view of A. and D. is a rear view of C. D. is a mirror view of A. (that is, right and left hand reversed) and C. is a mirror image of B. A. of Figure 9 is sometimes called a left handed bowline, (in which case D. would be right handed) but A. is the standard manner of tying the bowline and in net

making A. is commonly tied when working toward the right. Naturally, any one of these four phases shown in Figure 9 appears differently when tied upside down.

Individual net menders have their own preferences in the manner of making the knot but tie differently when working from right to left than when working in the reverse direction. For example, one man may tie A. when working from left to right and tie D. when working to the left. Another man may tie C. to the right and B. to the left. In mending a jagged hole the knots are often tied upside down.

In machine woven webbing, one "round" (horizontal row of half meshes along the strip) is made as A. The next round is tied as B. upside down. The third round is tied again as A. and so on alternately.

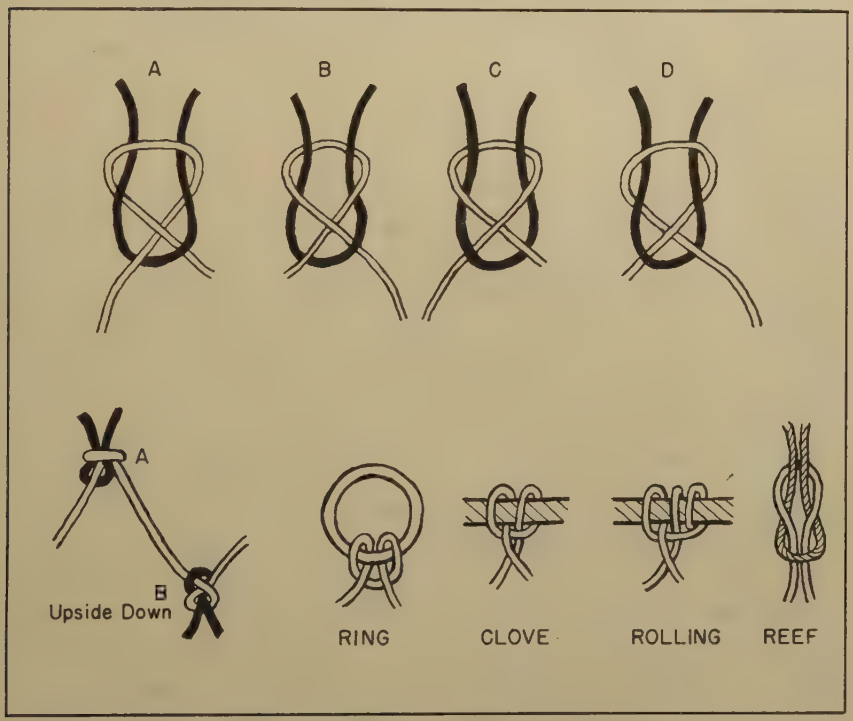

FIGURE 9. Four aspects of the fisherman's knot and other knots commonly used in net hanging

Four other knots are commonly used in net construction. In hanging webbing to a line, in attaching purse rings to their bridles and on many similar occasions a ring hitch is employed (Figure 9). This simple knot is also called lark's head, barrel, bale or cargo sling hitch or tag knot. In place of this a double half hitch (clove hitch) may be used. When hanging to a line or chain, the clove hitch may be replaced by a "rolling hitch" which resembles a clove with a third turn around the line. Lines, slings and eye splices are frequently joined by interlocking loops forming a "reef knot" which is essentially a square knot (Figure 9).

Mesh

A mesh of a net is one of the openings enclosed by the knotted cords forming the fabric of the net. In the plural sense meshes are the openings and the cords enclosing them. Therefore, there is no sharp distinction between many "meshes" and "webbing" but the term meshes is generally used in a restricted sense as referring to relatively few openings.

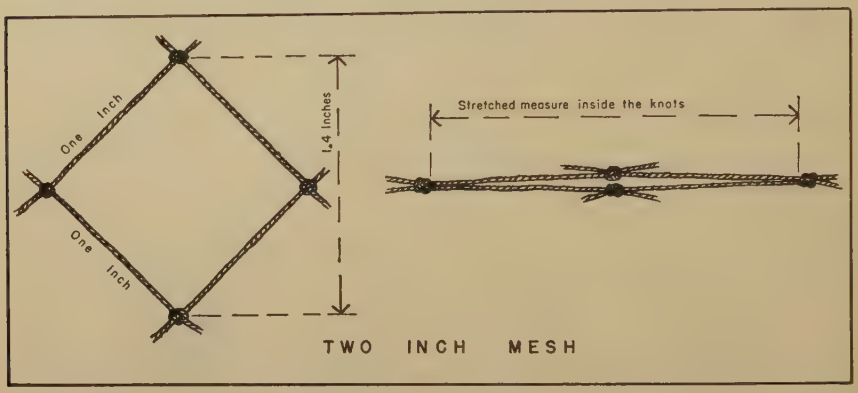

FIGURE 10. A two-inch mesh, open and stretched

In some parts of the world, mesh size is measured along one of the four sides of a mesh opening. This is the "bar" or "square" measure. In California by common practice and specifically defined by state law, mesh size is obtained by "stretched measure." This is the distance between two diagonally opposite knots of a mesh when the mesh is pulled shut by those knots. Therefore stretched measure is twice the bar measure for when a square of one inch on each of the four sides is stretched it will measure two inches. When a mesh is squarely open, the distance between two diagonally opposite knots is approximately one and four-tenths times one bar, that is, one of the four sides of the mesh (Figure 10). Since 1883 California law has defined the measure of a mesh as "inside the knots" rather than the distance from center to center of the knots. This is a sensible provision because it measures the escapement area for small fish regardless of the size of twine used in the net. The opening, center to center of knots, would vary with each size of twine because the thickness of one knot would be included in the measurement. In this publication references to mesh size apply to stretched measure taken inside the knots.

Submitting new cotton webbing to a pulling strain will stretch the cords and tighten the knots thus enlarging the meshes but this is more than offset by the shrinkage caused by tanning or dipping in tar or other net preservatives. Not only must this shrinkage be allowed for in hanging the pieces of webbing but larger meshed webbing must be ordered from the factory. This anticipating of the final mesh size is tricky because the shrinkage is a variable depending upon the degree of strain in the different parts of the net, the frequency of dipping in net preservative and the nature of the net dip, hot or cold, tanbark, tar or patented chemical preservative.

Selvage

Literally, selvage is a protected edge of a fabric. In fishing nets the term is so used but in addition it includes several forms of reinforcing. The edge of a piece of webbing usually has a doubled cord for the outside one or more tiers or rounds of half meshes (Figure 12). The edge may be reinforced by hand-woven meshes of heavier twine and larger mesh. The strain on the edge may be relieved by a broad strip of heavier webbing or the selvage strip may have several graduations in the weight of cord and mesh size. (Figure 30). All of these forms of reinforcement serve to protect the webbing by distributing the strain and are referred to as selvage. Most roundhaul nets have small mesh selvage at the top so that the corks of the headrope will not became tangled in the meshes. Selvage just above the footrope is usually of large mesh to offer less resistance to the water when pulling the leadline and there is little chance of entangling the rope in the meshes. Either end of a heavy seine is protected by a vertical strip of selvage, sometimes called the breast strip. The mesh sizes, twine weight and arrangement of selvage strips varies widely in different purse seines.

Twine Size

Most seine twine is cotton thread twisted into a strand and three strands are twisted together to form a cord. The degree of twist in the threads and strands determines the "lay" or hardness of the cord. There are four degrees of hardness—soft, medium, medium-hard, and hard—but most fishing nets are made from medium-laid twine. Sometimes hard-laid is used in portions of the net subject to strain or abrasion and lacing twine often is hard-laid. Cord size is designated by the total number of threads used. Sizes from 6 to 36 increase in intervals of three threads, one to each of the three strands. From 42 to 60 the intervals are six or two threads to each strand. From 72 to the heavy No. 168 twine the intervals are 12 threads and in the very heavy cord the intervals are somewhat irregular.

In cotton seine twine, as in Manila rope, the twist of the strands is commonly "right handed" or "plain laid." Cable laid twine or rope is twisted in the reverse direction. However, the question of lay is more involved. In plain laid twine or rope the plant fibers or "yarns" are twisted into threads in a direction called "right handed" when looking along the rope and is counter clockwise as becomes evident when viewing the cut end of the cord or rope. Threads are twisted into a strand in the reverse or "left handed" direction (clockwise). Three strands are then joined by the opposite twist which is right handed when looking along the rope but counter clockwise when viewing the cut end of the rope.

Cotton fibers are cleaned and graded as to quality, staple length, etc., and are then gauged as to diameter of the fiber. Almost universally, gauge 10 is used for netting twine. Occasionally a finer 20 gauge fiber is used. Smaller gauge (30 and 40) is not used in ordinary commercial fishing nets in this State. The fibers are then twisted into threads which vary in size according to the gauge of the fibers used, but commonly 10 gauge. Threads then form strands and three strands form the finished cord. The direction of twisting may be plain or cable laid but left handed lay is very rare in seine twine. The 10 gauge is so universally used that the 10 is assumed and not written in designating the twine size. If a gauge other

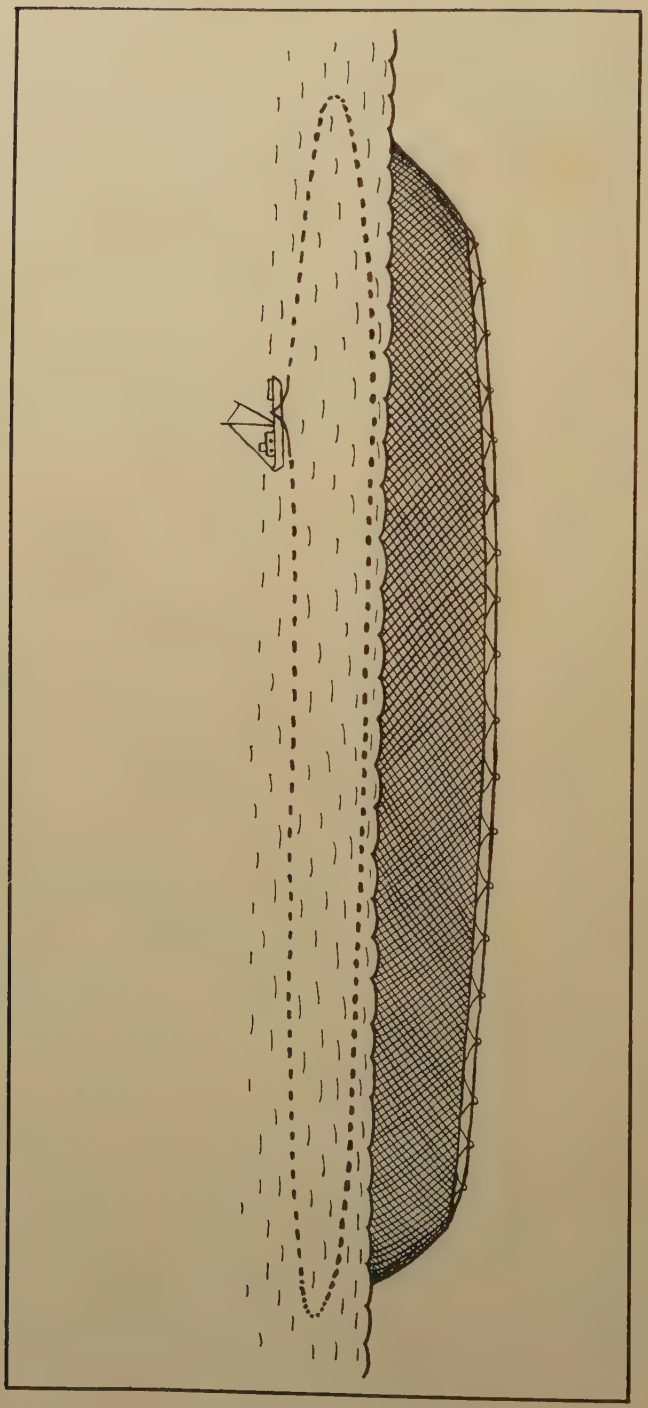

FIGURE 11. A purse seine circled and ready for pursing. The net and boat are to scale. Cup shape of the net is indicated. Drawing by the author.

than 10 is used it is designated. For example, a nine thread cord is 10/9 but is written #9. If of finer 20 gauge fibers, the cord is designated as 20/9. This 20/9 cord, because of the finer gauge, is of smaller diameter than the ordinary six thread cord made up from 10 gauge fibers (#6). Cords #6 and #9 are commonly used in roundhaul nets and the finer webbing 20/9 is sometimes used. Our fishermen usually refer to this light cord (20/9) as cable laid but this is in error for all we have seen has been plain laid.

Rope size is in inches either as diameter or as circumference but in these pages diameter is used unless otherwise stated.

Hanging

The putting together of pieces of webbing to make up the net is called hanging and herein lies great skill. Upon skillful hanging depends the right degree of fullness in parts of the net, proper relief of strains by selvage and, on the whole, the proper behavior of the gear in the water and the fishing success of the completed net. In roundhaul nets, webbing is very seldom cut to a taper, but the oblong piece is inserted and taper is accomplished by a "take-up" or "pick up" of meshes in hanging. As an example of taper, suppose the piece to be added is of the same mesh size as the upper piece in the net. Every third mesh of the added piece may be hung to two meshes of the upper piece thus reducing the number of meshes at the ratio of four to three.

A piece of webbing may be hung to another piece of the same mesh size or to a piece of smaller or larger mesh. It may be hung to large selvage meshes or to a strip of heavy selvage. Also a piece of heavy webbing may be hung directly to a line, in which case the lacing or "stapling" to the line is frequently called "hanging in" (Figure 12). In most such cases, extra webbing is hung in to allow for shrinkage of new webbing when treated with tar or other preservative and additional allowance may be made for the desired degree of fullness in the finished net. Allowance is made also for the stretching under use of new rope for lead and corklines.

A roundhaul net in the water is not a truly vertical wall of webbing but the net is hung so that it is roughly cup shaped when laid out in a circle (Figure 11). This is accomplished by a leadline shorter than the corkline. For purse seines and ringnets there is a rule of thumb that the leadline will be 10 percent shorter than the corkline but the trend in the last few years has been toward 10 fathoms of corkline to 9½ fathoms of leadline. Additional fullness of the webbing contributes to the cup shape of the net in the water. The degree of fullness varies in different seines but the following may be considered the hanging plan for a typical purse seine of 1951. Ten and one-half to 11 fathoms of webbing are hung in to 10 fathoms of corkline with the take-up divided between stapling the upper selvage (1½ meshes wide) to the corkline and lacing the second selvage strip to the first (Figure 30). The main body of the webbing (four or five horizontal strips) is then hung without take-up, that is in the ratio of one to one. The bottom strip of main webbing (11 fathoms) will be hung to 9½ fathoms of leadline. This take-up of one and a half fathoms will be divided between hanging to the leadline selvage strip and stapling this selvage to the leadline.

Lampara nets are hung so that the cup shape is exaggerated into a scoop with a much shortened leadline and a large bag (bunt) of webbing.

Cork and Leadline

To keep the upper edge of the net at the water surface the webbing is hung from a headrope or corkline upon which corks or other floats have been strung. To keep the webbing upright, the lower edge is laced to a footrope or leadline weighted with sinkers, usually leads or chain.

Stapling

Two pieces of webbing when joined along a seam are "hung" or "laced" (lower half of Figure 12). Lacing twine wound on a netting needle is used in sewing the seam, over and under through the seam meshes, and knotting every foot or two so as to check raveling in case

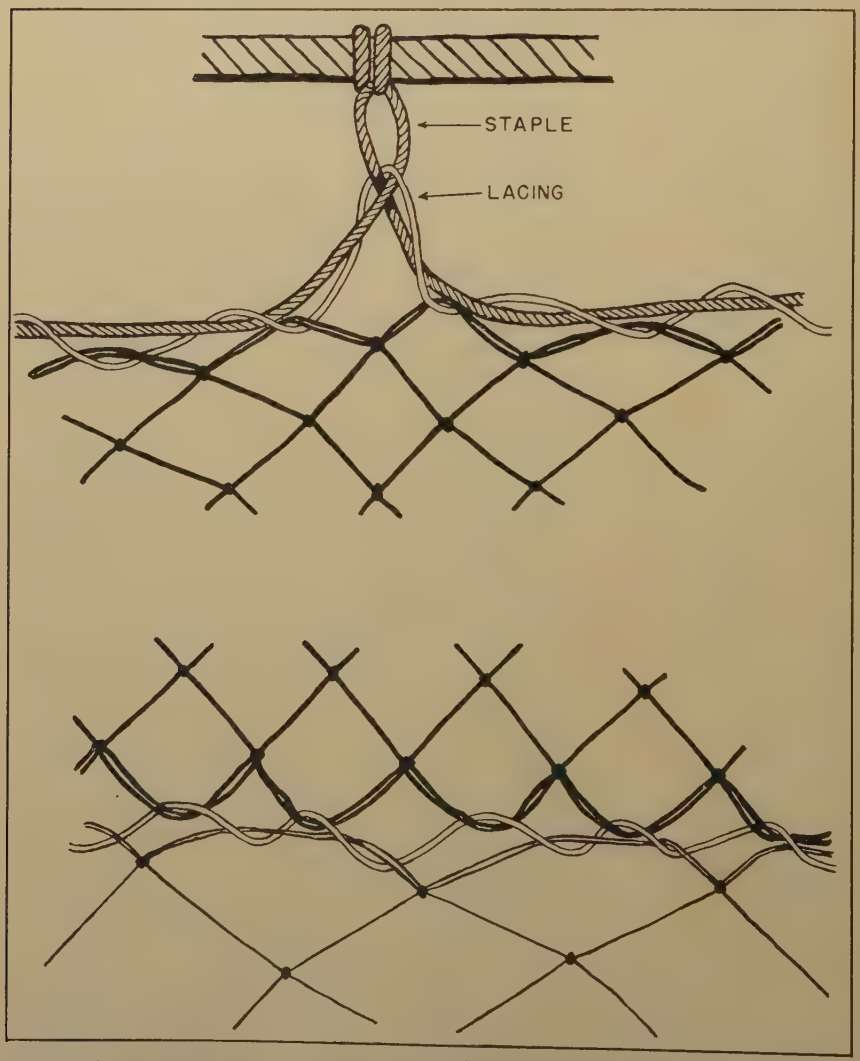

FIGURE 12. Heavy cord stapled to a rope. Lacing shown as lighter white cord. Lower drawing shows lacing together of the selvage edges of two strips of webbing of differing mesh size.

of a broken lacing twine. When webbing (nearly always a selvage strip) is hung to a line (corkline, leadline, end line, or chain) it is laced with a heavy hanging twine in loops. The loop is formed by knotting the hanging twine to the line at six or eight inch intervals, usually by a clove hitch or sometimes a rolling hitch which is similar to a clove with an extra turn around the line (Figure 9). The rolling hitch is generally used when hanging to a chain. This lacing to a line by knotting and loops is only occasionally called "stapling" by our fishermen but the word is descriptive and distinguishes this type of lacing from the other forms. In these pages, therefore, the word stapling is used to indicate hanging to a line by knotting loops or staples (Figure 12).

Bag and Wing

The bag of a roundhaul net is a cup-shaped fullness of the webbing at some portion of the net to serve in impounding the catch in a more confined area during the haul. Landing bag, sack, bunt and belly are names often used. The term "brailing piece" would be more specific. The bag of a purse seine or of a ringnet has but little more fullness than the remainder of the net so that it is recognized by the heavier webbing where the catch is finally held for brailing into the boat. By contrast, the bunt or bag of a lampara is a large and deep pouch in the center of the net. In the center of this bunt, just under the corkline, is a landing bag or brailing piece of heavier twine.

The wings of a lampara and a ringnet are the ends of the seine and the two wings are pulled simultaneously to impound the catch in a central bag. The two wings of a lampara or of a ringnet should be designated as right and left when facing the mouth of the bag as the wings of a theater's stage are named right and left when viewed by the audience.

The purse seine has a bag at one end which is shot first and hauled aboard last and is stacked on top of the net ready for the next layout. This end is called the bag or sack end but is frequently referred to as the skiff end. The opposite end of the seine is often called the wing end. Because it is the end hauled in first after the layout it is frequently called the haul end.

Purse

In fishing net terminology "purse" is used as a verb and adjective but seldom as a noun. Literally to purse is to close an opening by pulling a line which has been threaded through rings attached to the edges of the opening. Money used to be carried in a pouch closed by a draw string—hence purse. In roundhaul nets there are several different kinds of pursing devices, the most important being the closing of the bottom of a net after it has been circled about a school of fish. Floats along the headrope of a net are bunched by hauling a cork purse line through rings on the corkline. At either of the lower corners of a purse seine the leadline is brought to the surface by means of a short purse line through rings on the end of the net (breast line). The central portion of a leadline is brought to the surface and the wall of netting closed off by pulling a vertical line through rings on the

webbing. This is more graphically called a "zipper." Closing and opening of the pouch of a dipnet (brail) is accomplished by a miniature purse line (tripline) through rings.

Breast Line and Davit Loop

For many years, the end of a purse seine has been strengthened by a heavy rope. This was the corkline carried beyond the upper corner of the net to form a loop, spliced or heavily lashed at its base, and then extended down the end of the webbing to the lower corner of the net (Figures 17 and 30). Frequently it was extended back along the leadline a couple of fathoms. Formerly this rope at the end of the net was called the "up and down line" and the upper corner bite was called "the loop." The up and down line is now commonly referred to as the "breast line." The loop at the bag end of the seine is sometimes called the "davit loop" because it is taken aboard and made fast at the vessel's davit at the beginning of the haul. The loop at the opposite end of the net (haul or wing end) may be called the haul loop. The breast line (at either end of a purse seine) serves to recover the lower corner of the net and bring the end of the leadline to the surface. Along the breast line is lashed a series of three to six small rings through which is threaded a lighter line called the "breast purse line" running from the lower to the upper corner of the net end (Figure 17). This short purse line usually is spliced to a ring at the lower corner of the net and the upper end is tied with a slip knot into a "sling" or additional loop at the base of the davit loop. This pursing of the breast line not only brings the end of the leadline to the surface but in many nets it is the means by which the end of the purse cable is recovered preliminary to closing the bottom of the net.

EARLY HISTORY OF ROUNDHAULS IN CALIFORNIA

FIRST CANNERIES AND FIRST PURSE SEINE

The first fish cannery on our Pacific Coast was established in 1864 at Washington (now Broderick) across the river from Sacramento for the packing of Sacramento River king salmon taken in beach seines. The first sardine cannery (Golden Gate Packing Co.) was built in June, 1889, at North Beach on San Francisco Bay and it operated until August, 1893. Fish were caught in the bay by "haulseines" (beach seines) (Smith 1895). The pack was mostly anchovies in one-fourth-pound cans with oil (quarter oils) and large sardines in one- and two-pound round tins. The appearance of sardines in the bay was irregular and small ones suitable for the quarter oil pack were scarce. In December of 1893, the machinery of this plant was moved to East San Pedro (Los Angeles County) and set up as the California Fish Company. Later the name was changed to the Southern California Fish Company. Sardines and mackerel were packed in cans sealed by hand soldering.

In 1894 the "Alpha" under Captain Young supplied the fish for this San Pedro cannery. This was a 22-ton sloop-rigged vessel with gas engine but sail was used while scouting for fish. There was a seven-man crew including captain and cook. This is our first clear record of purse seines used in California (Smith 1895). Two such seines were carried, one for sardines and a large one for mackerel. Two vessels were employed, the tender and a seine boat. The catch was brailed on deck by a hand windless

where sideboards at the gunwale permitted carrying a 16-ton capacity deck load. The hold was not used for fish. Fishing was confined to the daylight hours when schools were sighted at the surface. The areas fished were San Pedro Bay, off Redondo Beach, and around Santa Catalina Island. A haul of as much as 10 tons was exceptional and the usual catch was confined to the three- or four-ton per day limit set by the cannery (Fry 1931). The sardine purse seine was 120 fathoms long by 8 fathoms deep and the mesh was at first 1½-inch but as small sardines gilled in this net it was replaced by a one-inch mesh net. The large mackerel seine was 135 fathoms long by 17 fathoms deep and of two-inch mesh.

The second sardine canning operation in California was begun at Monterey in 1902 by F. E. Booth who packed first in a lean-to shed. A cannery building was erected in 1903 under the firm name of the Monterey Canning Company. Large sardines were packed as "Monterey mackerel" and the then standard one-pound oval shaped salmon can was used, resulting in that can becoming the accepted sardine tin for many years. The first year (1902) the catch was made with gill nets but in such small quantities that they were replaced by purse seines in 1903. A second sardine cannery was established at Monterey in 1906.

EARLY PURSE SEINE FLEET AT SAN PEDRO

During 1894 the first purse seine vessel in California, the "Alpha," used purse seines at San Pedro, one for sardines and one for mackerel. She fished several years but after the first season or two she caught, in addition, the so-called "whitefish," that is, yellowtail, barracuda and white sea bass (Skogsberg 1925, page 9). Between 1895 and 1898 two other seine boats were built at San Pedro and the three vessels fished primarily for the canneries rather than for the fresh fish markets. This period of small scale fishing by three or four seiners at San Pedro lasted nearly 20 years. Whitefish supported the seiners and they more and more left sardine fishing to the lampara crews after 1906-8.

In 1914 another seine boat was built at San Pedro. This was followed by four additional vessels in 1915, two in 1916, and two more in 1917. In 1918 eight additional seiners were built at San Pedro and an equal number came to Southern California from Puget Sound. Purse seining was proving very successful. Additional canneries wanted fish and the three species of "whitefish" found sale in the markets and canneries. The taking of local bluefin tuna in purse seines was being tried out and proving successful. The purse seining of local bluefin tuna began in 1915 (Whitehead 1931, p. 8). In 1919, 17 seiners were built locally and many additional boats came down from the northwest to join the San Pedro fleet. In 1920 there were 15 new boats and more arrivals from Puget Sound so that the total fleet consisted of about 125 purse seiners operating out of San Pedro.

This proved to be the big year in number of boats but 1920 was not a boom year financially for the fishermen. The good catch of bluefin tuna was divided between too many boats and the catches of other species were not satisfactory. Prices were dropping and the Country was suffering from a postwar economic slump. In 1921 boats began returning to the Northwest and by 1922 many had left San Pedro. Others were tied up or were serving as tenders so that the operating fleet was reduced to about 65 vessels.

During this period of boom and decline in the seining of "whitefish," albacore canning developed. It started experimentally in 1906 or 1907 and one San Pedro cannery packed a little in 1908. This tuna is not purse seined but the albacore boom established new canneries which later made possible large catches of other species of tuna, sardines and mackerel. In 1911 occurred the first important pack of albacore at two canneries, one in San Pedro and one at San Diego. In 1912 there were five tuna canneries, in 1913—9, 1914—11, 1915—12, and in 1916—16.

EARLY PURSE SEINES AT MONTEREY

At Monterey, purse seines were first used in 1903, nine years after they were used at San Pedro. From 1903 to 1905 they supplied sardines to the Booth cannery where the old hand flaking and sun drying method was followed and cans were hand soldered. Fish was carried from the boat to the cannery in wicker baskets. Fishing operations were conducted from a light double-ended "Sacramento River seine boat" which towed a skiff. The seine was circled by hand from the skiff and pursed from the seine boat. The purse line and the seine itself were pulled by hand. The seine was long for those days, 200 fathoms by only 12 fathoms deep and was made up of one-inch mesh of No. 6 cord. To hand pull such a net required a crew of 10 or 12 men in addition to the captain. One crew was supposed to supply the daily capacity of the cannery which was 10 tons but the landings were erratic and often failed. Hand pulling 200 fathoms of one-inch mesh was necessarily slow. Hauls were made in shallow water to prevent the escape of fish through the bottom of the net before it could be hand pursed. Fish were located by seeing them flip at the surface in the daytime. Little was known of the behavior of schools and the boat had difficulty in finding fish. At first the cannery furnished all equipment and the fishermen were paid wages. Two of these men, years later, told the writer that the wage system encouraged them to anchor out of sight of the cannery for a game of cards and return in the late afternoon reporting no fish. The inadequate purse seine catches of the 1903-05 period led to the trial of the lampara net in 1905.

After 1905 sardine fishing at Monterey improved. The success of the lampara was largely responsible but there were other reasons. More was learned of the behavior of schools. It was discovered that sardines could be located at night by the luminescence caused by the movement of fish in the water. Also wage payment to fishermen was supplanted by the share system in which payment was made per ton of fish delivered with each crew member drawing a share and the investment in boat and net drawing two or more shares. Although the early purse seines were rapidly replaced by lamparas soon after 1905, a few remained in the fishery for several years. One or two seine boats continued in use at Monterey until 1914 or 1915 (Scofield 1929).

LAMPARA PERIOD

As a remedy for the poor catches made by the early purse seines at Monterey, one of Booth's best fishermen, Pietro Ferrante, suggested trying a Mediterranean roundhaul called "lampara" that had been a good sardine net during his boyhood back in Italy. Accordingly in 1905 Mr. Booth purchased a lampara from Tangier, the first one seen in America. This net was worn out and could not be fished but it served as a model for the

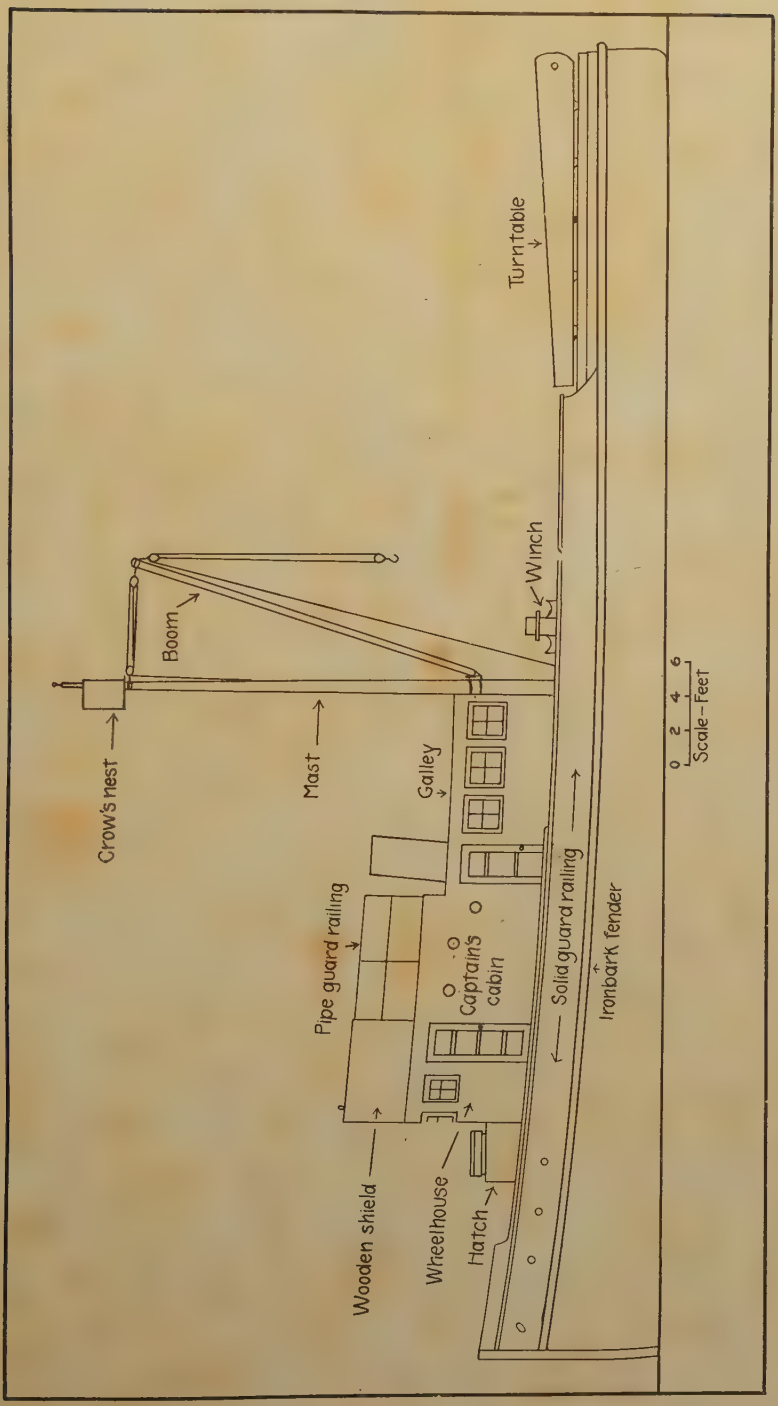

FIGURE 13. Side elevation of a purse seine boat. By S. S. Whitehead, 1931.

construction of other lamparas which were successful. As the sardine canning industry grew in the southern part of the State the new nets added were lamparas and purse seines dropped out so that within four or five years after 1905 the sardine fishery at both Monterey and San Pedro was dominated by lamparas rather than purse seines. However, purse seines continued in use at San Pedro for "whitefish" and later for tuna.

The lampara differed radically from the purse seine. It had no purse line or rings. It was not a straight wall of webbing of uniform mesh size. It depended upon a large deep bag to impound the fish. The wings were of very large mesh and the two wings were pulled simultaneously. In San Pedro the lampara (called a "roundhaul" in Southern California) was altered somewhat from the nets in use at Monterey. Soon two types of modified lamparas were developed, one used by the Japanese crews and another, known locally as the Italian roundhaul (Higgins and Holmes 1921).

After the introduction in 1905, the lampara period in California covered more than 30 years. In the first 10 years they practically drove the purse seine out of the sardine fishery and in the next 10 years (1915-1925) nearly all sardine nets in the State were lamparas. After 1925 purse seines were reintroduced and ringnets were developing after 1929 but lamparas persisted until after 1930 although losing ground rapidly. Many survive even now (1951) as bait nets.

SECOND PURSE SEINE PERIOD

During the decade 1915-25, sardine fishing in this State was by lampara or by a variation of that net. There were no purse seines at Monterey and at San Pedro and San Diego purse seines were used or tuna and "whitefish" but not for sardines.

At San Pedro in January, 1925, a Norwegian tuna purse seine skipper made up a small mesh seine and tried it out for sardine fishing. This was like a reincarnation of the old San Pedro purse seiner "Alpha" of 31 years earlier. It was at once a success and by mid-November of 1925 there were 25 purse seine vessels employed regularly in the sardine fishery at San Pedro. In the following year still other purse seiners turned to sardine fishing at San Pedro.

In 1926 two purse seine vessels were sent from San Pedro to Monterey but from 1926 to 1929 they were not very successful in competition with the lampara. In March of 1929 there were 61 sardine crews fishing regularly at Monterey. Of these, 56 used the lampara, two crews used purse rings in their lamparas, one crew used the Japanese net or "shizuoka" and two crews were purse seiners.

By this time more purse seiners were sardine fishing at San Pedro and the competitive struggle was on between the two nets--purse versus lampara. This struggle was in the sardine fishery only. The lampara type of net was not used for tuna. Tuna seining in Southern California has continued to be by purse seine nets from the days of the first fish canneries to the present (1951).

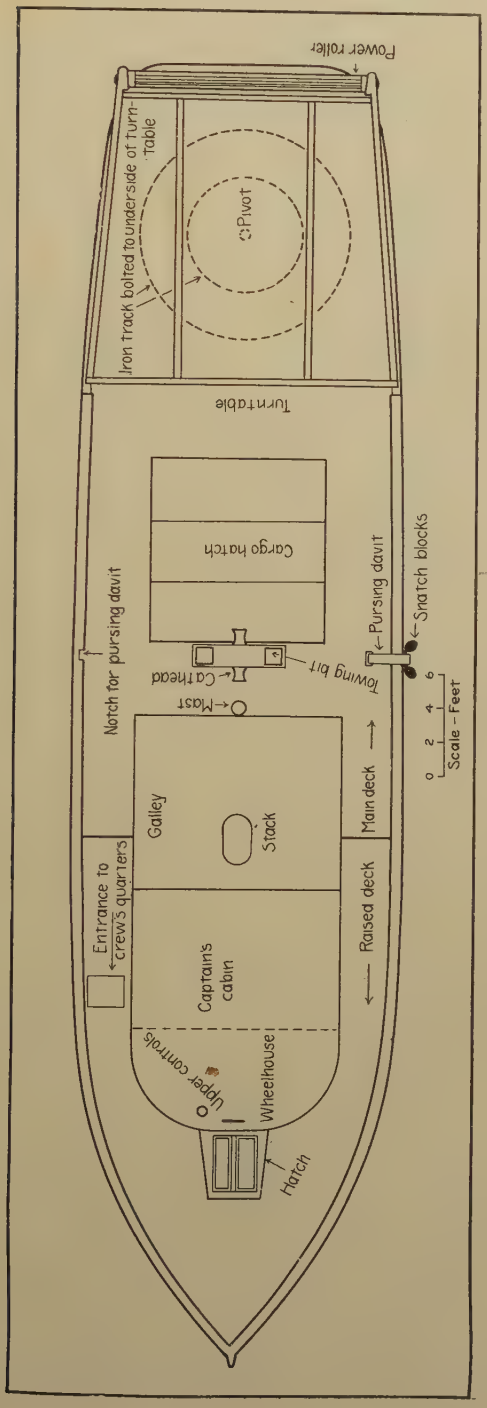

FIGURE 14. Deck plan of a purse seine boat. By S. S. Whitehead, 1931.

DEVELOPMENT OF RINGNETS

After the lampara was introduced in 1905, fishermen netmakers experimented with modifications of the original model but for 12 or 13 years there was no important development of the net except that in Southern California the lampara was considerably enlarged and the Japanese crews built a simplified but deeper bag with a larger area of small mesh webbing. A Chinese variation at Monterey was very similar.

In 1917 one or two sardine crews at Monterey and in 1918 crews at San Pedro tried using purse rings along the central portion of the bag so that when the wings were partly hauled in the leadline could be hauled in more quickly to prevent escapement of fish through the bottom of the net (Scofield 1919, p. 41). This quicker closing of the net bottom was supposed to improve the daylight hauls and make possible the use of a shallower net that could be more quickly hauled. This modified lampara was called locally a "purse-lampara." These early trials at pursing the leadline were not very successful, probably because they interfered with the scooping action of the net. It is probable also that the purse action of the bag would allow fish to escape through the large mesh at the base of the wings. Whatever the reason, the purse-lampara was not used at Monterey during the years 1919-1925. Two additional haul lines were tried (Fry 1931, p. 11). These were attached to the leadline, one at each corner of the bag and made fast to the wing about 15 fathoms from the tip. They were to serve in closing the leadline more quickly when hauled in separately from the leadline.

Soon after the 1925 return of purse seines to sardine fishing, the competition between purse seines and lamparas became evident and lampara fishermen were anxious to try anything that would improve their lampara catches. In the spring of 1927 a significant reduction in the size of wing mesh in lamparas was noted at San Pedro and by 1928 practically all of the San Pedro lamparas had been rigged with purse rings along the bag of the net (Scofield 1929, p. 27).

At Monterey one Japanese crew in January, 1928, added purse rings to their lampara bag and in August of that year one Italian crew tried it. A third crew tried the purse rings but soon abandoned them. Up to March of 1929 only two crews at Monterey were using the "purse-lampara" but in the following two or three years many Monterey lamparas were equipped with purse rings.

The typical lampara had three-inch mesh along the leadline under the bag, the wing base was five-inch and the wings were graduated out of 14- or 16-inch mesh at the wing tips. Adding purse rings to the leadline of the bag closed the opening of the net bottom more quickly but the three-inch mesh of the bag had to be reduced to prevent sardines escaping. This meant the depth or fullness of the bag should be reduced to lessen the area of small mesh which slowed the speed of the haul. Also the mesh size of the wings was reduced to prevent escapement and the rapid taper in depth in the wings was reduced. In other words, the scooping action of the old lampara was being abandoned for the impounding principle of the purse seine. The net was being altered by less fullness of bag, more uniform mesh size throughout, deeper

wing tips and greatly reduced mesh size, except in the upper two-thirds of the bag where it always had been small.

At Monterey, this altered lampara with purse rings under the bag was called a "half ring" net because the rings were attached to approximately the central half of the leadline. This name later was adopted in San Pedro and supplanted the older name "purse-lampara."

Altering the lampara continued and the fullness of the bag was still further reduced. Wings became uniform in depth and mesh size became the same throughout the net. Purse rings were extended the full length of the leadline. Finally the net closely resembled the purse seine except that the landing bag was in the center of the net instead of at one end and the two wings were pulled simultaneously instead of the purse seine method of pulling only one end of the net. The ringnet retains little to remind us of its lampara origin, except in the method of hauling into the boat, which harks back to its Mediterranean ancestors. Except for the method of hauling, the ringnet had evolved into what for all practical purposes could be called a purse seine.

The name "half ring" persisted even after its significance had been lost when purse rings had been extended the full length of the leadline. Since the net is no longer half ringed, the obsolete name should have passed with the gear. For want of a better name this purse net pulled from both ends at once is called a ringnet.

At the present time we can generalize as to superficial differences between a ringnet and a purse seine. Ringnet boats are generally smaller than purse seiners. Ringnets themselves are more apt to be tanned and less apt to be tarred. Ringnets usually are piled on the stern deck rather than on a turntable. In piling the net the leadline and corkline usually are piled athwart ships rather than fore and aft along one gunwale as is common with purse seines. There are exceptions to the above statements. Large ringnets may be longer than some purse seines. Some ringnets are tarred and some few purse seines are tanned. Occasionally a purse seine is operated without a table and the method of piling the net on the stern is not always consistent.

PURSE SEINE VERSUS LAMPARA FOR SARDINES

In the early days the purse seine was the only available net for taking sardines and mackerel in quantity for the canneries. The daylight hauls were small. With the development of night fishing, hauls were larger. Still the net was heavy and the crew was necessarily large. When the light-weight lampara was introduced it had the advantage of a smaller crew and shorter time required to complete the haul. It was operated from boats that averaged smaller and with less investment than the purse seine vessels but the hold capacity and cruising range were less. As canneries increased in number and capacity the demand for fish increased and new fishing grounds were tapped at greater distances from port. Here the purse seine vessels had an advantage in cruising range and hold capacity. When power pulling of the purse seine developed, the advantage over the hand pulled lampara or the ringnet was great and the purse seine has now driven the other nets into small scale bait fishing. The necessary restacking of one wing of either the ringnet or lampara has not been the determining disadvantage. Restacking could be done

while scouting for the next haul. The contest was engine versus hand pulling and mechanical power won. In the future, lamparas, with power pulling added, might regain some of their former importance at the next spin of the wheel of fate.

SUMMARY OF HISTORY

1826.	Purse seine invented for menhaden in Rhode Island.
1864.	First fish cannery on Pacific Coast. Salmon at Washington across from Sacramento, now called Broderick.
1889–Aug., 1893.	First sardine cannery, North Beach, San Francisco.
1893, Dec.	Sardine cannery at San Pedro.
1894.	First purse seine in California at San Pedro. Sardines and mackerel. Vessel "Alpha."
1895–98.	Three purse seine vessels at San Pedro.
1902.	Booth packed gill net sardines at Monterey.
1903.	First purse seine at Monterey. Booth built cannery.
1903–5.	Only purse seines at Monterey.
1905.	Lampara from Tangier, Algeria, introduced into America at Monterey.
1906.	Tuna canning began at San Pedro.
1906–12.	Lampara replacing purse seine for sardines both at San Pedro and Monterey.
1914.	Two purse seiners and many lamparas at Monterey.
1915.	Last purse seine at Monterey. At San Pedro purse seines for tuna and white fish. Lamparas for sardines.
1915–25.	Lamparas only, for sardines at Monterey and San Pedro.
1917.	Half ringnet tried at Monterey with little success.
1918.	Half ring tried at San Pedro without success.
1920.	About 125 purse seines at San Pedro for tuna and whitefish.
1925, Jan.	Purse seine revived at San Pedro for sardines.
1925–28.	Purse seine generally adopted for sardine fishing at San Pedro in competition with lampara.
1926.	Two purse seiners sent to Monterey.
1927–28.	Development of ringnets.
1929.	At Monterey 56 lamparas, two purse seiners and two ringnets.
1930–40.	Ringnets replacing lamparas.
1940–50.	Purse seines replacing ringnets.

BRIEF DESCRIPTION OF EARLY NETS

MONTEREY LAMPARA 1922

In 1922 fish canning at Monterey was confined almost entirely to sardines and fishing was by lampara nets. There were seven canning plants with a combined normal daily capacity of 335 tons or an average of 48 tons per plant. These plants were supplied by 29 lampara crews, an average of one crew to each 12 tons of plant capacity so that most of the time each boat operated on a daily limit set by the cannery at an average of about 10 tons. A boat crew made one to seven hauls per night (averaging three to four) to get its 10-ton limit. A gasoline engine launch (average length 34 feet) carried the net and crew of 8 to 10 men. A towed lighter 25 to 35 feet long carried the catch. Fishing was at night when the moon was not shining because schools were located by the luminescent light caused by the movement of fish in the water. The net was laid out in a counter clockwise circle around the school and immediately hauled from both ends simultaneously while a scare was worked over the side of the boat to keep fish from streaming under the vessel.

The lampara net was characterized by a large and relatively deep bag (bunt) of small sized mesh with two tapering wings graduated in mesh

size from 5-inch at the base to 14- or 16-inch at the tip. The function of the wings was to frighten fish into the bag where they could be held till partial pulling of the wings closed the leadline under the school. The circle of the net layout was distorted by pulling the wings till the net assumed the shape of an old-fashioned grocer's scoop. The take-up in hanging the several pieces of webbing to form the large bag resulted in this net being the most complex piece of fishing gear used in California. (For detail of hanging see Scofield, 1929, pages 28 to 33.)

The Monterey nets of 1922 were 170 to 200 fathoms around the corkline with an average net 190 fathoms long by a little over 30 fathoms deep at the base of the wing. The bag proper was an area of three-fourths- or one-inch webbing about 40 fathoms long by 20 fathoms deep with about 12 fathoms of three-inch mesh webbing below the small mesh. This three-inch mesh was called the bed or floor of the net and was hung so that it formed, with the inch mesh above, a very full cup shaped pouch. This bag proper was flanked on either side by two pieces five fathoms long, the upper of one-inch mesh 20 fathoms deep and the lower piece the same length 12 fathoms deep of three-inch mesh. These pieces formed part of the bag. Along the corkline of the bag and directly in the center was a piece of webbing six fathoms square of very heavy cordage to resist abrasion while brailing. This was called the landing bag.

The wing in most cases was made up of three parts. The base about 13 fathoms long by over 30 fathoms deep was 5- or $5\frac{1}{2}$-inch mesh. The intermediate part of the wing was 6- or 8-inch mesh 15 to 20 fathoms long by about 30 fathoms deep. The wing tip was about 30 fathoms long of 14- or 16-inch mesh ending in an 18-inch stick (brail).

During the six or eight years following 1922 there was decided expansion of the sardine canning industry at Monterey. New canneries were built and the number of fishing crews doubled. Larger launches were built, lighter capacity was increased and beginning in 1927, diesel power replaced gas engines. In 1926 purse seining was given another trial but there was relatively little change in the lampara net which became standardized at about 200 fathoms long and was modified only after the competition from purse seiners became severe.

LAMPARA AT SAN PEDRO 1921

At San Pedro in 1921 the sardine fleet was made up of two types of boats, using somewhat different styles of lampara nets and manned by fishermen of two different nationalities. About one quarter of the fleet comprised Italian boats built before albacore trolling became important. They were designed for trammel netting halibut and setlining rockfishes and were smaller, older and slower than the Japanese boats. They averaged about 35 feet in length and carried crews of five or six men. About three-fourths of the sardine fleet consisted of newer and faster Japanese boats designed for albacore trolling. They ranged in length from 45 to 50 feet and were worked by crews of seven or eight men. Both types of boat carried the catch on deck by using sideboards over the low gunwales. The largest of the Japanese albacore boats could carry a load of 25 to 30 tons of sardines on deck (Fry 1931, page 11). Fishermen of nationalities other than Italian and Japanese were engaged in other fisheries, especially in purse seining tuna, barracuda and white sea bass but purse seines were

not used for sardines at this time. Most of the fishermen of San Pedro trolled for albacore during the summer season.

At San Pedro the Italian lampara was called a "roundhaul" and the lampara introduced from the homeland by the Japanese was referred to as the Japanese net. Both types had one characteristic in common; each was built in three detachable sections, a bunt and two wings. The Monterey lampara wings were not detachable. At San Pedro there was greater diversity in size and construction of lamparas than at Monterey. Most of the San Pedro nets were made up from webbing imported from Japan at lower cost than local twine. The Italian "roundhauls" resembled the Monterey lamparas but had smaller wing mesh. By contrast, the Japanese nets were considerably larger and deeper requiring more men in the crew.

The typical Italian net was 150 to 200 fathoms around the corkline and 15 to 20 fathoms deep. The bag was about 40 fathoms long and each wing 80 fathoms or less. The main body of the bunt was 1-inch to 1¼-inch mesh and the bed had 2½- to 3½-inch mesh. The tapered wing in three sections had a base 10 fathoms long of 3-inch, the next section 45 fathoms long of 8-inch and the wing tip 25 fathoms long of 12-inch mesh terminating in a two-foot brail stick. (For detail of hanging see Higgins and Holmes, 1921.)

The Japanese nets were 200 to 250 fathoms along the corkline and 25 to 30 fathoms deep. The bunt was 30 to 50 fathoms long with the wing three to three and one-half times this length. The bunt was of ¾-inch mesh with the bed sections 3½-inch. The longer wings were made up of three to five pieces graduated in mesh size from the base of 3-inch to the tip of 8-inch mesh. It was claimed that these nets had less small mesh, in proportion to their greater size, than the Italian or Monterey lamparas. The net plan does not seem to support this conclusion and similar Japanese nets at Monterey were discarded because of the large areas of small mesh requiring more labor in the haul. However, the greater fishing depth of the Japanese lampara seems to have been an important point in its favor at San Pedro.

The San Pedro sardine fishery (1921) was exclusively by lampara, either Italian or Japanese. Purse seines were used extensively for tuna, barracuda, yellowtail, white sea bass and mackerel. However, there was some fishing for these species by lampara nets as well as by other gear such as trolling, gill nets, set lines and live bait pole and line fishing. The lamparas used for these species (other than sardines) were much the same as the sardine nets except that the mesh sizes were larger and the size of twine used was necessarily much heavier to hold these larger fishes. The bunt of these lamparas was usually 2- to 3½-inch mesh with 4- to 5-inch mesh in the bed along the leadline. Most of the mackerel lamparas were of No. 15 thread medium-laid cotton twine but nets for the larger fishes were made up with 18- to 21-thread twine (Skogsberg 1923, p. 78).

SAN PEDRO PURSE SEINES 1922

Although the sardine fishery at San Pedro (1922) was exclusively by lampara net, purse seines were in common use for other species of fish and contributed a large share of the catches of bluefin and yellowfin tunas, bonito, mackerel and the three so-called "whitefish" which in those days meant barracuda, yellowtail and white sea bass. Later there was legislation against purse seining "whitefish." The three whitefish species

usually were taken inshore in rather shallow water whereas the tunas were caught offshore in deeper water. Tunas were stronger swimmers and more active so that schools were more apt to sound or dive under the leadline while the net was being pursed. These differences led to the use of two different seines, alike in plan but differing in length and depth of net, in weight of twine in the webbing and in size of mesh. Whitefish seines were comparatively smaller and lighter, whereas tuna seines needed to be longer, deeper and heavier.

In general, the smaller whitefish seines were more uniform as to dimensions and mesh size. The tuna seines showed wide variation in length, depth, in the number of threads and in mesh size of the webbing strips used to make up the nets. Whitefish seines were 220 to 240 fathoms long by 14 to 19 fathoms deep. Tuna seines were 250 to 290 fathoms long by 25 to 30 fathoms deep.

Mesh sizes in the whitefish seines were $2\frac{1}{2}$, $2\frac{3}{4}$ or 3 inches in the upper strips with four to five inches in the bottom strip. Small mesh, not over $2\frac{1}{2}$-inch in the upper part of the net was preferred when taking barracuda because of the frequent gilling of small barracuda. Mesh size in tuna nets was usually $3\frac{1}{2}$ to 5 inches in the supper strips with a wide variation of 4 to 15 inches at the bottom. Mesh sizes were not evenly graduated from small in the upper portion of the seine to large at the bottom, as illustrated by Tables 1 and 2. These demonstrate also the difference in depth between the two types of net.

TABLE 1

Whitefish seine			Tuna seine		
Strip number	Mesh size	Number meshes deep	Strip number	Mesh size	Number meshes deep
1	3	200	1	3½	150
2	2¾	200	2	5	100
3	2½	75	3	6	50
4	4½	50	4	3	100
			5	3	100
			6	4	100

Nearly all the webbing used was medium-laid cotton seine twine with much heavier cordage in the tuna seines. Skogsberg (1923, page 90) gives the twine size for the different mesh sizes used in these purse seines (Table 2).

TABLE 2

Whitefish seine		Tuna seine	
Size of mesh	Twine number	Size of mesh	Twine number
2½ – 2¾	15 – 21	2½ – 2¾	18 – 21
3 – 3½	18 – 21	3 – 3¾	24 – 27
4 – 5	21 – 27	4 – 5	33 – 42
		6 – 7	42 – 48
		8 – 15	42 – 60

Although there have been many minor improvements recently in purse seining, the nets and methods of operating them were pretty well perfected by 1922. Net hangers were accomplished in allowing for the differences in shrinkage in webbing of different mesh size and twine weight and in hanging-in webbing to cork and leadlines to get the proper uniform fullness along the whole net. Selvage strips were used at cork and leadlines. The boats were provided with turntables and pursing was by winch although hauling in the wing was by hand pulling. Ratio of depth of net to length was one to 10 but, then as now, it was hard to find a net that complied with this rule of thumb. The leadline was about 10 percent shorter than the corkline. Seven-inch galvanized iron purse rings were hung along the leadline by bridles and the purse line was in two or three sections joined by a figure eight coupling. In shooting the net, a heavy skiff pulled the bunt end, called the "skiff end" into the water first (left wing in a clockwise layout) and when the circle was completed, the last wing (right wing of a clockwise layout) or "haul end" was pulled aboard and stacked on the turntable. The catch was brailed from the bunt or skiff end where the fish had been concentrated.

The arrangement at the end of the net for lifting the leadline was much the same as now. The corkline at the upper corner of the webbing was extended beyond the webbing and doubled over to form a free loop and then extended down the end of the webbing where it was called the "up and down line." This protected the end of the webbing. To this line were attached two-inch purse rings without bridles and through them ran a light line called "brail line" (now called breast purse line) used to bring the leadline and lower corner of the net to the surface. This was called "brailing" and the small rings were called brail rings. This device bunched the end of the net when desired and accomplished what a brail stick would do in a smaller seine. It therefore could be called brailing in the original sense of the word brail. The brail line was made fast near the end of the leadline and the free end was tied to the free loop. Also the end of the purse line was made fast to the free loop where it could be quickly recovered at the conclusion of the layout. The 10-fathom skiff line was made fast to the free loop and the 80- to 100-fathom haul line was made fast to the free loop at the other or haul end of the net. Skogsberg made no mention of corkline purse rings to bunch the floats but this idea may have been suggested by the "cork rope" of these early seines. This was a line running from the free loop at the skiff end out six to nine fathoms along the corkline. Its purpose was to help in pulling the skiff end of the net up to the side of the vessel at the conclusion of the layout.

RINGNETS, 1930

The ringnets of 1930 (Fry, 1931, p. 17-29) had tapered ends, tanned webbing and consisted of a central bag of small mesh with two wings of larger mesh. The typical sardine ringnets ranged in length from 180 to 250 fathoms by 25 to 40 fathoms deep, which was an average of about eight fathoms deeper than the purse seines of equal length. The webbing of the bag was $\frac{3}{4}$- to $1\frac{5}{8}$-inch mesh with $1\frac{1}{2}$-inch in most nets. Twine was 20/6 or 20/9. The landing bag or brailing piece, 14

to 16 fathoms square, was 9 to 15 thread. The webbing strips of the brailing piece were horizontal but the strips in the remainder of the bag were either horizontal or vertical, with crews equally divided as to their preference in net plan. The ends of the bag were submitted to a horizontal strain as the crew hauled in and a vertical strain by pursing so it made little difference which way the strips were hung. Strips of the wings were hung vertically as the strain of hauling would be horizontal. The wings were usually of three mesh sizes with 6 to 12 fathoms of 4-inch at the base next the bag, 6-inch midway in the wing and 8- or 9-inch at the wing end.

The corkline selvage of the bag was 6 to 24 inches deep of $1\frac{1}{2}$- or $2\frac{1}{2}$-inch mesh 36 thread. Leadline selvage ranged from four feet to four fathoms deep 5-inch mesh of 15 to 30 thread. In the wings, the corkline selvage two fathoms deep was 3- or 4-inch mesh. Leadline selvage of wings was either lacking or a strip of 3- to 5-inch mesh. Purse rings were small, four to six inches. Bridle lines were $\frac{3}{8}$-inch rope, 12 to 15 feet long hung so that rings were $2\frac{1}{2}$ to 4 fathoms apart.

In hanging ringnets the leadline was 5 to 10 percent shorter than the corkline. Bag webbing was 15 to 30 percent longer than the corkline and there was usually additional fullness of webbing at the brailing piece. Fry noted a trend toward less taper in the wing ends. This was a step in the modification of the ringnet toward the purse seine with square ends.

The sardine ringnets at Monterey were shorter than the San Pedro nets and the wings were considerably shorter. Ringnets used for mackerel in 1930 were a little shorter than the sardine nets and usually of 2-inch mesh. A few large ringnets were built for tuna fishing, even up to 340 fathoms of 5-inch mesh and 8-inch wing mesh (Fry 1931, p. 30).

MODERN ROUNDHAULS

GENERAL REMARKS

A Purse Seine Haul

In order that the uninitiated may have in mind the sequence of events, the following brief outline of a purse seine haul is presented. We assume the normal counter clockwise layout. The net is stacked on the turntable, the bag end on top and the wing on the bottom of the pile. The skiff or skiffs ride on top of the piled net. The vessel cruises, usually with lights out, to find fish. When a school is located it is scouted to determine suitability, movement and currents. The skiff with skiff line of the net is put overboard and the net is pulled into the water (bag first) as the vessel circles to port completing the layout not far from the skiff. The haul line of the wing is retained aboard after the last of the net wing goes into the water. The vessel picks up the skiff line and hauls in to recover the bag end of the net and its purse line. The two davit loops are hung on the davits and a scare is operated to keep fish from escaping under the boat. Purse lines are run over gypsyheads and pulled in to close the bottom of the net. The purse cable is wound on spools to be out of the way. Bunched purse rings are hoisted aboard by boom and lights are turned on. The purse line is unlinked and pulled out of the rings, being replaced by light rope and the rings are temporarily stowed on deck at the starboard rail. The cork purse lines are pulled to bunch the corks, the turntable is given a half turn to reverse ends. Strapping in the end of the wing begins, that

is, it is power lifted to the boom end and as lowered it is stacked on the table ready for the next layout. The skiff is brought alongside and the outrigger stick is made fast to the skiff. Strapping in the wing continues. If the catch is large, a portion of the net may be pinched off or zippered and the cut portion of the fish brailed aboard. All the wing may be brought aboard leaving the catch dried up in the landing bag from where it is brailed. After brailing the bag end of the seine may be dragged in the water a mile or so to wash it. The ends of the purse cable are threaded through the purse rings, the table is revolved a half turn back to normal position and the vessel, now towing the skiff astern is ready for a second haul.

Variations

One should not expect to find two roundhaul nets just alike, especially such complicated pieces of gear as the modern purse seine. Each skipper has his own pet ideas and crew members work in some of their preferences when helping to make up and hang the net. Comparatively new features may be incorporated that increase the catching power of the gear but in the great majority of cases there are numerous minor variations that are of no particular significance. For example, some crews prefer that the purse line link supporting the ring have a quarter turn twist in it so that the rings tend to hang at right angles to the footrope and may nest a little closer when lined up on the turntable. There is no uniformity in the arrangement of corks. If there are enough of them the gear catches fish regardless. Other nonessential variations come about through utilizing the materials on hand rather than purchase of new and expensive items. Thus old strips of webbing or pieces from another net may be worked in although of a different mesh size or twine weight. Old strips of selvage, odd sizes of corks and left-over lead weights are utilized and slightly worn rope is inserted even though of a diameter differing from the general net plan. Occasionally sections of used purse cable replace a piece of worn manila rope, even in the corkline for a few fathoms at the end of the seine. Short pieces of cable are often used to strengthen some point in the net. As a result, there may be such variation that in some cases it is difficult to determine just what was the original plan of the net.

Preservation of Nets

In general, the large and heavy purse seines are tarred. The ringnets and lamparas are tanned, but there are many exceptions. Tar is seldom used on lampara and bait nets but is often applied to ringnets. Some purse seines are tanned. Small bait nets usually are treated with one of the copper compounds. Beginning about 1935, or before, it was not unusual for purse seiners to tar new webbing or an old net at the beginning of a fishing season and thereafter treat them with tanbark two or three times through the season. Tar is generally considered a better net preservative and the treatment does not have to be repeated for some time but it makes the webbing stiff and heavy to handle. New webbing shrinks by about 10 percent when treated with tar. The shrinkage is less with tanning but each successive treatment with preservatives causes some additional shrinkage. The use of tanbark should be repeated oftener than once a month but this is usually neglected during a good fishing season and as a result the bark treatment is not considered to have the preserving quality of tar. Many different coal tar mixtures are sold and some skippers do their own

blending. Purse seines going into warm southern waters for tuna often prefer a different preservative, such as Seattle pine tar. In tanning, chipped bark of the tan oak is boiled and the net immersed for a few hours in the solution. In any case, the best practice is to give the net a thorough washing in sea water before stacking for even a day or two. If the stack time is longer, a generous sprinkling with dry salt while stacking helps preserve the webbing.

Usually a piece of webbing lasts about two fishing seasons, with the result that a net may be in operation for six or eight years but in the meantime most of the webbing has been replaced three or four times.

Period of Large Purse Seines

During the last 12 or 15 years there has been a trend toward larger purse seine vessels carrying larger nets. New boats added to the fleet through the years were successively larger. There developed between tuna purse seine skippers a rivalry to operate the largest vessel with the greatest hold capacity. A full load of high priced tuna in these larger holds paid big returns to the fishermen but when the catch was less than the full capacity of the ship, the losses were proportionately greater on the doubled or trebled investment. The law of diminishing returns operated for tuna purse seiners as it has in other forms of business expansion.

The race for larger vessels and nets came to a peak about 1948, in which year seven or eight purse seiners over 100 feet long were built. For example, one of these new vessels measured 107 feet in length and carried a tuna seine 425 fathoms around the corkline. Another of 128 feet had a seine of 420 fathoms and a new 117-foot vessel carried a 450-fathom net.

The winner of the 1948 race for size was the "Santa Helena," an all-steel vessel 135½ feet in length, with a hold capacity of 350 tons of tuna, and a crew of 14 men, and was said to have cost, fully equipped, about a half million dollars. The hold was refrigerated and the ship carried all the navigational aids including gyroscopic steering. The turntable and 25-foot motored skiff were of steel.

This vessel carried the largest purse seine operated in the State, said to be 600 fathoms on the corkline (Pacific Fisherman 1948 B.). Some months later it was reported that this net had been considerably reduced in length for easier handling. The dry weight of the original net which cost $35,000 was estimated at 30 tons. This huge net was about 46 fathoms deep, which was considerably more than the average of tuna seines. Such a large net required heavier webbing than would be used in the average seine. The following is a brief description of the mesh and twine sizes used. The top strip of webbing was 30 meshes of 4½-inch mesh of 96 thread twine. Below this were four strips, each of 100 meshes of 4½-inch 72 thread followed by a 100 mesh strip of 4½-inch 60 thread. On the bottom were two strips, each of 50 meshes 8-inch mesh of 96 thread. A ⅜-inch galvanized iron chain served as footrope. The purse line was 1,000 fathoms of cable, the central portion being ¾-inch with ⅝-inch cable on the ends. The headrope carried 12,000 corks supplemented by 200 canvas covered rubber floats. A complete layout and haul of this seine required a little over two hours exclusive of time spent in brailing and stowing fish.

Since 1948 the trend has been away from the extra large seines and medium sized nets are preferred, 200 to 300 fathoms long. The large seiners were converted to live bait tuna fishing.

Shares

In many cases the fishing boat is owned outright by the skipper. The vessel may be operated for the owner or partial owner, either an individual, a partnership or a company. Often canneries advance the money for building the vessel in order to be assured of the catches and the skipper pays back the advance in fish delivered. In some cases the boat builder, the engine company supplying "the mill" or a bank may be part owner. In a few cases the ownership, in whole or in part, is shared by the crew members.

The common practice through the years has been to operate the vessel on a sharing basis, that is, some plan of dividing the earnings of the vessel between crew members and the investment in boat and net. A simple method was to divide the earnings into a number of "shares," one to each member of the crew and five to eight shares to the boat and net. Usually there has been an allotment of an extra half share to the skipper or acting fishing boss. Certain operating expenses, for example fuel, food and fees in foreign countries, came out of the gross earnings before shares were computed, thus each crew member indirectly contributed his portion of these costs. Other expenses, as engine overhaul, boat repair and gear replacement have been considered as part of the investment and paid by the boat and net owners. In general,

FIGURE 15. A modern purse seiner. Note two skiffs riding the net. Photograph by Kent Hitchcock, 1947.

labor of construction and repair of gear is contributed by the crew and the materials used are charged to the net or boat.

The number of shares or portion of the gross earnings allotted to the boat and net has varied through the years and has been the subject of considerable dispute between the boat owners associations and crew members unions. An example of the division of shares of a decade ago is as follows: One share to each man of the 11-man crew, an extra half share to the skipper, four and one-half shares to the boat, three to the net and one share to incidental expenses, totaling 20 shares. As a result of arguments over boat shares, the system of allotting was changed three or four years ago but the change was in form rather than in principle. Now the boat and net allotment is figured as a straight percentage of the gross earnings rather than an indirect percentage in the form of number of shares. This percentage varies according to the size (overall length) of the vessel. The boat and net percentage plus the operating costs are deducted from the gross earnings and the remainder is shared by the men of the crew. The skipper or masthead fishing boss still gets an extra half share or more and the engineer may get an additional fraction of a share but these usually are charged against the boat share rather than against the crews' portion.

The percentages due the boat and net are given in the accompanying table. There are variations from these figures in special cases.

TABLE 3

Boat and Net Percentage

Boat Length in Feet	*Percent*	*Boat Length in Feet*	*Percent*
50 to 54.9	28	80 to 84.9	37
55 to 59.9	30	85 to 100	39
60 to 67.9	31	100.1 to 110	40
68 to 73.9	33	110.1 to 125	42
74 to 79.9	35	125.1 to 149.9	44

These boat percentages apply along the California coast in both sardine and tuna seining but in case the purse seine boat is refrigerated and fishes tuna south of the United States boundary, an additional three percent is added to the boat share. Live bait boats fishing tuna in waters south of the boundary are allotted a larger share for their heavy investment but there are heavier charges against the boat share so that the final allotment between boat and crew is roughly similar. For example—food is now considered a personal expense of a purse seine crew and therefore is charged against the crews' share, but not against the boat. This applies on purse seiners but on the tuna bait boats food is an operating expense and charged against both boat and crew.

Crew members belong to local unions affiliated with national organizations. There are some differences between the union rules for cost allotting. For example, one group classes the depth finder as contributing to the safety of the vessel while the other group considers it as an aid to fishing and therefore subject to sharing of the rental cost. There are differences in the method of charging certain wharfage fees. There are questions of social security deductions and the proportioning of costs and shares in case of a change in crew members. The bookkeeping becomes so involved that an accountant is engaged to report the allotment of shares. Some canneries donate the bookkeeping chore of making "the settlement."

On a purse seiner fishing sardines and mackerel the number of men sharing in the catch is 10 or 12 with the average of 11 crew members including the skipper, cook and engineer. Boats seining tuna, with larger and heavier nets, average 12 men. Naturally the largest boats often carry an extra man or two and the "baby seiners" may have a crew of only seven or eight men. The Italian boats, as a rule, carry one or two more men than a similar sized boat with a Slavonian or mixed crew. These men were in advance of the Italians in adopting improvements such as power pulling of the seine and it may be that the larger Italian crews of today are a holdover from a few years past. Also the Italians, with more sentiment than cold blooded business acumen, are more likely to make a place on the boat for some relative in need of a job.

Direction of Layout

The direction in which a school of fish is circled while the gear is shot is a matter of custom and varied somewhat in the past. In present day purse seining nearly all crews lay out from right to left, that is, counter clockwise. The rule is that the leadline and purse rings are stacked on the side the vessel turns toward. This would be the port side in a counter clockwise layout. Also the outrigger pole and davit are on that side. The corks of a purse seine are piled fore and aft on the opposite side and drums of cable are located to starboard or on top of the house to be out of the way.

Skiffs

Since the earliest days of purse seining, a large skiff was operated with the fishing vessel. It now serves to help in pursing the corks and to hold up the outer side of the landing bag for brailing the catch. The skiff developed into a very heavy and beamy "pumpkin seed" craft 20 to 26 feet long by 12 to 16 feet beam. Later it was powered with an inboard engine. In recent years many crews have added a second skiff, smaller and lighter, called the baby. It is a general utility craft and when traveling to the fishing grounds it rides nested in the seine skiff on top of the stacked net.

Floats

For years past, the standard material for floating headropes has been the bark of the cork oak cut into disks two to three inches thick and four to six inches in diameter. A hole in the center permits threading on a line. In recent years, other materials have supplemented cork. Up to five or six years ago inflated rubber balls were next to cork in importance. Balls, 16 to 24 inches in diameter, inclosed in a cover of net webbing, were attached to the headrope when additional buoyancy was needed. Metal balls were found to be too heavy and awkward to stow. Canvas covered inflated rubber bags about two feet long by 10 inches in diameter are used extensively. In the last five or six years, the shape of corks has been imitated in rubber and threaded on, rather than attached to, the headrope. A common form is inflated rubber disks about seven inches in diameter by $3\frac{1}{2}$ inches across, resembling small sized balloon tires. More prevalent have been "corks" made of "spun" or "foam rubber," a new material said to have been developed by our armed forces during the last war. These are much lighter than cork and cost much less. Foam rubber corks came into general use in this State about 1945 and are now

gaining in popularity. Oval shaped plastic corks have been tried. They are very light but, as yet, are too expensive.

Heavy nets, especially tuna purse seines require all the floats possible on the headrope but they cannot be threaded in a solid continuous string. Two considerations limit the spacing of corks: stapling and hand holds at intervals free of floats on the line. Every 6 to 10 inches along the headrope there should be an inch or less of space between corks so that selvage webbing may be stapled to the line. Groups of corks should not exceed two feet or so and then should be followed by a one-foot interval of line free of corks so that a man may have a hand hold on the headrope while handling the net in hauling or stacking.

RECENT DEVELOPMENTS

Influences on Fishing Effort

During the last two decades there have been many improvements in the operation and construction of roundhaul nets. A few of these developments have shortened the time required to complete a haul, thereby increasing the catching power of the boat and net as a unit of fishing effort. One or two devices have profoundly affected the locating of fish schools, thus tending to increase the potential catch per boat. Several of the changes in gear have only slightly improved the handling of the net but the sum of these new devices has affected the fishing success of each vessel.

In several instances a device considered as new actually had its origin many years ago but until it was adopted by an appreciable percentage of the fishing vessels it did not contribute much to the fishing success of the fleet. The date of general adoption is therefore more significant than the date of invention or first trial.

Tapered End and Landing Bag

The lampara net had an exaggerated taper from the deep bunt to a slender wing tip. Ringnets, as they developed from the lampara, had tapered wing ends. The typical purse seine had square ends with only a slight and scarcely noticeable narrowing at the ends. The tapered wings of a ringnet were simpler to manage and during the period when the lighter nets were competing with the heavier purse seines a number of seiners adopted the tapered wing end but retained the square end at the bag. Now a good many purse seiners, even the large tuna nets, are tapered at both ends (Figure 16).

In the past, the position of the landing bag was one of the characters distinguishing ring from purse seines, the ringnet bag in the center and the purse seine bag at one end. Starting some six or eight years ago a few roundhauls were made with two landing bags, one smaller for use when the catch was light or both when the catch was heavy and required splitting. Bag is now a misnomer because there is no longer a bunt or additional fullness of webbing. The landing bag is actually a brailing area of heavier weight twine. Some purse seines now have two, three, or even four brailing areas. After the leadline is pursed, the catch may be divided by a zipper in the net or the webbing may be pulled up to cut off or pocket a portion of the catch at one of the brailing areas. The pocket may be brailed out and the hauling aboard of the net continued till another pocket is formed as before. Instead of a zipper at each landing bag, many nets

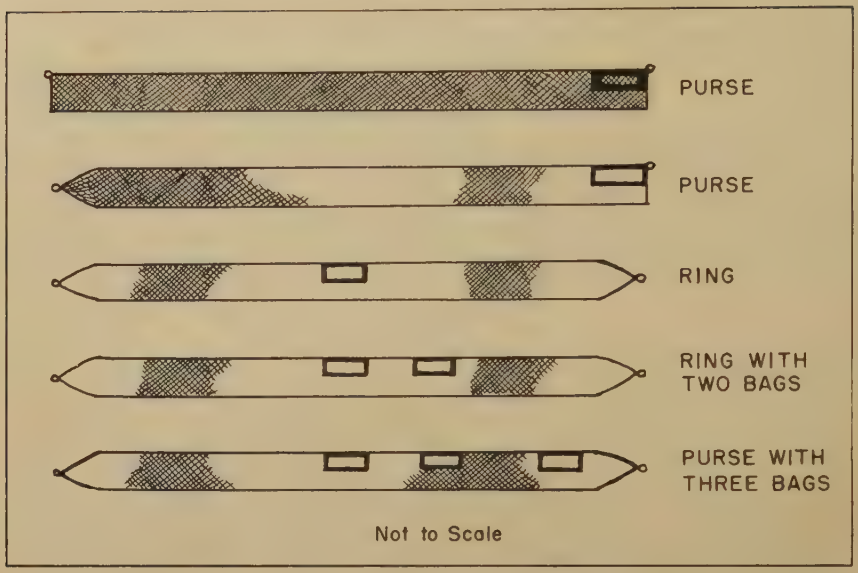

FIGURE 16. Diagram to show variation in the square and tapered net ends as well as location of the landing bag.

have the points marked by painted corks or a colored string down the net to indicate where the webbing may be lifted to form a pocket (Figure 16).

Tapering wings and position of the landing bag can no longer serve in distinguishing between purse and ringnets. The two nets are almost identical in appearance when seen spread out ashore. The method of stacking aboard the vessel differs but the remaining distinction is in the method of hauling—two wings at once or by one wing. This is a distinction with little difference and as ringnets are becoming scarce it may be that no useful purpose will be served in the future by differentiating between the two.

Wire Purse Lines

The early purse seines and ringnets employed a heavy manila rope as purse line to close the bottom of the net. In California, the first substitution of a wire cable for a purse rope was during the heyday of the lampara when these nets had driven the purse seines out of the sardine fishery. Not that lamparas were pursed, but in January 1925 Captain J. Berntsen of the "Mable" reintroduced at San Pedro the purse seine for sardines. In 1927 he made a trip back to Norway where he saw fishermen using a flexible steel wire cable as a purse line. He ordered one shipped to California and found it very successful. This is thought to be the first one on the West Coast. Very soon the Alaska herring boats adopted this device. As purse seines gradually came back in the California sardine fishery a few of the skippers employed steel cables for sardines and tuna and their use spread during the thirties. In the fall of 1940 many of the Monterey seiners changed to wire purse lines and by 1945 their use was quite general in this State.

The wire, although flexible, could not be coiled as the rope had been. Instead it was wound on reels turned by hand crank. The early rope and wire purse lines were in two parts joined by a link and swivel in the middle of the footrope. Standard purse seine gear now has the purse cable in three sections, the central one being of heavier wire. The end sections are commonly $\frac{9}{16}$-inch with $\frac{5}{8}$- up to $\frac{3}{4}$-inch in the central piece. The cable is wound on two reels and when the rings are bunched and boom-lifted aboard, the wire is removed and an attached light manila line is threaded through the rings to keep them in order as stowed along the port side of turntable (in a counter clockwise layout). The free end of the cable is rethreaded through the rings before the next set and made fast at the bag-end breast of the net to be in position for recovery at the next pursing.

Spring Shackle

When the purse line was rope instead of woven wire it was made fast at either end of the net to a sling at the foot of the davit loop. When each loop was in place at the vessel's davit, ends of the purse line were recovered and pursing began. When wire was used, a short rope was eyespliced to each end of the purse cable for easier handling at the davit loops. It was necessary to secure each end of the wire as otherwise it tended to run back through the purse rings.

In some nets the rope extension of the wire purse line was tied with a slip knot to a sling half way up the breast line. This took the pull of the wire while the net was circled. The rope extension, with considerable slack above the slip knot, was then tied by a second slip knot at the base of the davit loop so it could be freed easily and put aboard the vessel. It was at once run over a cathead and the strain pulled out the first or breast slip knot and hauled up the purse cable. This shortened the time before pursing could start. (Left hand sketch of Figure 17.)

A recent improvement has still further reduced the time required for recovery of the purse wire. It began in the last two or three years and rapidly gained favor during 1950. A spring shackle has replaced the swivel of the skiff line. The purse wire cuts across the lower corner or the net to the spring shackle. Here a large link is eyespliced into the wire and the link is engaged by the spring shackle (Figure 17). The wire extends on in place of the skiff line and is recovered by the vessel after the circle is made. The purse wire is power pulled, bringing in the corner of the net, davit loop and spring shackle. The shackle may be quickly opened, releasing the link in the purse wire which continues to come in under power pulling. Thus pursing has begun with the minimum of delay. The spring shackle is usually at the bag end only of the purse seine, in which case the wing end of the purse wire is made fast to the davit loop sling as in the past.

Cork Pursing

After the net has been pursed and part of the webbing hauled aboard, the loose corkline allows the floating corks to cluster at the bow and stern of the vessel with the probability that they will foul the propeller and catch back of the cutwater of the bow. To bunch the corks and control their drifting, light lines through rings on the headrope are pursed to hold the corks in compact clusters. At first there were two purse lines, one on each end of the net, each one covering one-third of

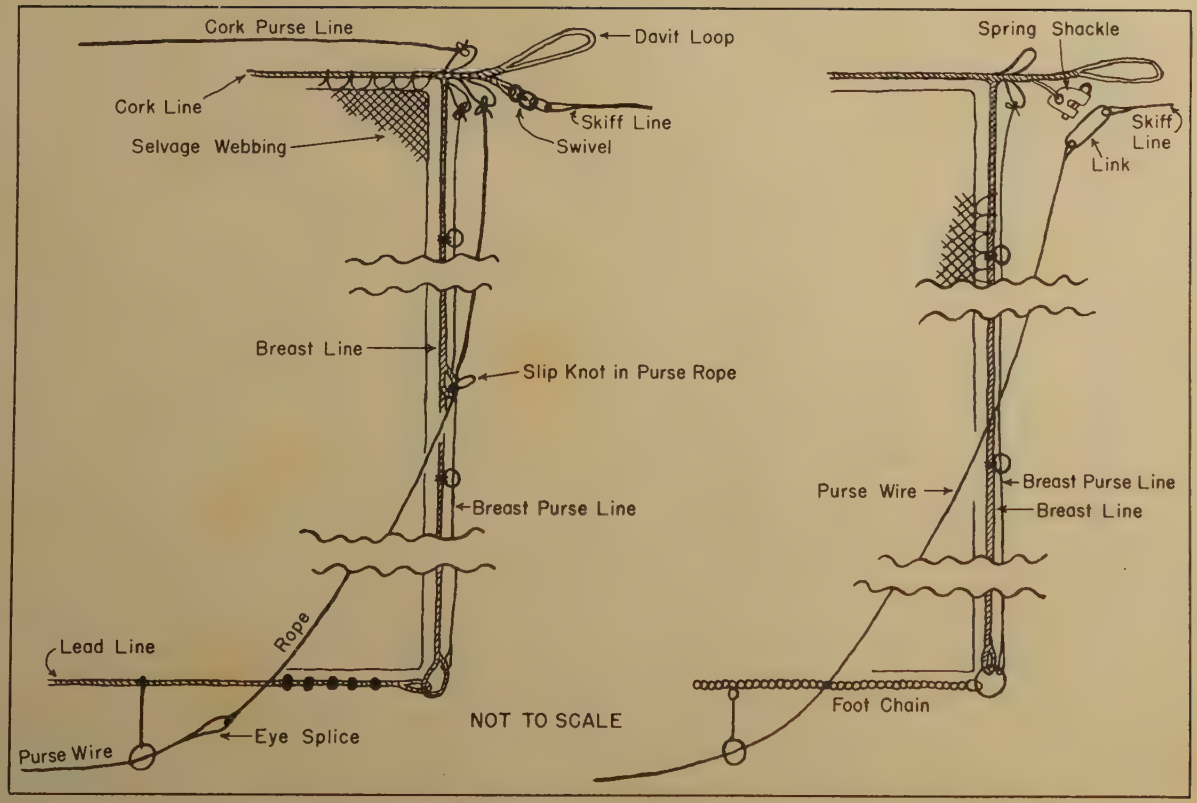

FIGURE 17. Diagram to show two methods of recovering the purse wire after the net has been circled

the headrope, leaving the central one-third of the net without cork pursing. This plan was replaced by several (three to seven) shorter purse lines extending all the way around the corkline. The longer lines over the ends of the net were pulled from the vessel, with the remaining lines pulled

FIGURE 18. Purse rings on deck in foreground. Crew members in background are pursing part of the corkline from vessels deck. Photograph by J. E. Fitch, August, 1948.

FIGURE 19. Circle completed and skiff has moved out to purse portions of the corkline. Photograph by J. E. Fitch. August, 1948.

FIGURE 20.—Skiff lashed to the stick. Corks being bunched about the skiff. Photograph by J. E. Fitch. August, 1948.

by hand from the skiff or later wound in over a skiff niggerhead (Figures 18 and 19). This was supplemented still later by additional rings on the headrope which could be threaded with shorter purse lines by men in the skiff. The last mentioned extra pursing was to support the corkline where a heavy catch was apt to sink part of the net.

The first experimental trials at hand pulled pursing of the corkline were made about 1925. By 1930 several of the boats employed such purse lines and by 1945 some form of cork pursing was common practice (Figure 29).

Zipper

A zipper is a device for lifting the leadline to the surface to divide the net in case of a large catch or when a small catch is to be confined to one end of the net. Splitting a net, with a large catch, allows brailing into the vessel with less trouble in keeping the corkline over the landing bag afloat. Usually this division or "cut" is made about midway along the corkline. A short vertical purse line lashed to the footrope runs through several small rings to the headrope where it is tied and marked by a painted cork. Hauling up on this line brings up the leadline and divides the net into two cuts at that point. The device may be very simple with the rings lashed directly to the webbing but usually they are made fast to a narrow vertical strip of heavier selvage webbing. Occasionally the zipper is more elaborate with the rings lashed to a $\frac{3}{8}$-inch vertical rope to which are stapled selvage strips, one on each side of the rope. This arrangement makes a convenient point to separate the net into two pieces for transporting, storage or dipping in a tank of preservative. The zipper purse line is often a $\frac{1}{2}$-inch rope through $3\frac{1}{2}$-inch rings spaced a fathom or so apart.

FIGURE 21. Power hoisting (strapping in) a purse seine. Photograph by S. S. Whitehead, 1930.

The Japanese crews are credited with first using the zipper in this State about 20 years ago. By 1950 most crews at Monterey and nearly all the Japanese crews fishing sardines had zippered nets and about half the Slavonian crews were so equipped. Few tuna nets have zippers.

FIGURE 22. Strapping in a purse seine. One bight being lowered from the boom end as men stack the webbing. Photograph by J. E. Fitch, August, 1948.

Power Pulling

The early purse seines were pursed and pulled aboard by hand. Pulling the purse line was such heavy work that soon the line was run over a cathead for power pulling. Lifting the bunched rings aboard remained such a task that it suggested using a block and tackle from the ship's boom and this in turn suggested, much later, the bunching of a portion of the webbing in a sling or "strap" and power hoisting it aboard by use of the boom. Now nearly all the pulling and hoisting aboard, of purse seines, is done by power. This development has so reduced the labor and time of making the haul that it has made possible more sets per night and thereby increased the catching power of the unit of gear. In the days of hand pulling, the crew could not risk many water hauls so that trial sets were seldom made unless the fishing boss was practically certain of a fair sized catch. Thus power pulling was a factor in the contest between heavy purse seines and the lighter ringnets and the still lighter lamparas.

FIGURE 23. Hand pulling a purse seine aided by the power roller of the turntable. Photograph by S. S. Whitehead, 1930.

Early in the history of purse seining a turntable on the stern of the vessel facilitated pulling and stacking the net for the next layout. The table, pivoted in the center, could be swung 90 degrees to either side. A roller on the aft edge of the table made pulling easier. Beginning more than 30 years ago (before 1920), power was applied to the roller to help the crew in pulling aboard the webbing. Power rollers were in general use for more than a decade in spite of the drawback that, whenever pulling in slackened for a moment, the power driven roller chaffed the net. Power hoisting by rope "strap" and boom made power rollers useless. This change from hand pulling over a live roller to power "strapping in" of a net came about in the early 1930's and by 1935 most purse seine crews were power pulling, the method still followed.

FIGURE 24. Power hoisting leadline and purse rings aboard. Photograph by S. S. Whitehead, 1930.

Beginning about 1945 in this State, a number of trawler vessels have been converted to purse seining without replacing the trawler winches already installed. These winches usually have two powered drums placed fore and aft. The purse line is pulled through snatch blocks, one end to each drum, and wound on the drum without rewinding on separate spools. Two gypsyheads furnish the power to hoist the rings aboard, to strap in the net wing, and to operate the brail.

Purse Ring Slip Knot

Beginning about 1945, a few skippers have tried out a simple device for releasing from the net the last six to nine purse rings of the wing end. This allows leaving the last 30 or 40 fathoms of wing stacked on the turntable when a small school of fish is encountered. In such a case the vessel makes a smaller circle in the layout and as part of the seine is not shot, the time required for the haul is shortened. In most purse seines the two purse bridles are joined by a link from which is supended the purse ring. In the slip knot device, there is introduced a two-foot rope between the bridles and the link of the purse ring (Figure 25). The upper end of this rope is eyespliced into the link or shackle of the bridles and the lower end is tied to the purse ring link by a slip knot. Pulling the slip knot releases the link, purse ring and the purse line threaded through the ring. Pursing of that portion of the net in the water may then proceed. As a portion of the wing is left on the table, the time required for hauling and stacking the webbing is cut down although a little extra time is needed afterward for retying the ring links for the next layout. This short cut may develop but as yet (1951) it is not common practice.

Powered Skiffs

Starting less than a decade ago, some of the heavy tuna purse seine skiffs were powered by an inboard motor. By October 1946 the writer estimated that 5 or possibly 10 percent of the seiner skiffs at San Pedro were powered. Since that time the practice has spread, chiefly among

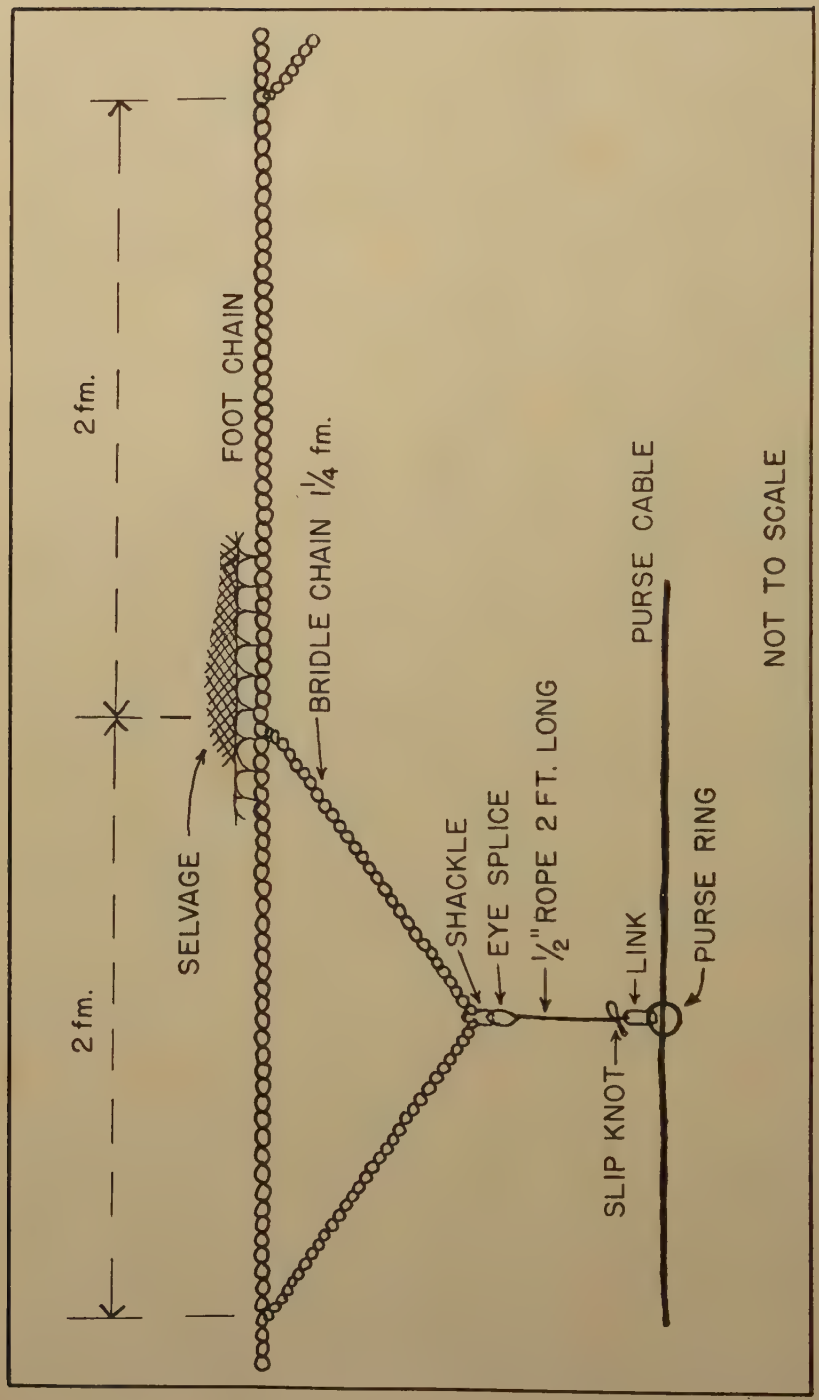

FIGURE 25. To show chain bridles and the slip knot to release purse rings and purse cable at wing end of a purse seine

tuna seiners. It was necessary to enclose the skiff's propeller in a metal cage to keep it from fouling the net. Most skiffs now have a niggerhead off the engine to serve in hauling the cork purse lines.

Refrigeration

In the early days of tuna fishing in the waters of Mexico the live bait boats (pole and line gear) carried chipped ice and some of the first refrigeration in these boats was for the purpose of retarding the melting of the ice. It was some time before the catch was hard frozen in insulated holds and still later before chilled brine was used. The early purse seiners for tuna delivered their catches to receiving barges in Mexico and later installed refrigeration coils for tuna fishing but removed them for the sardine season in California. At this time most tuna bait boats were refrigerated. Permanent installation of freezing coils in the larger tuna purse seiners began about 1945 or before and during 1946 many of the large seiners were equipped with refrigeration. By 1947 most of the larger seiners were so equipped and about 15 percent of them had installed tanks for chilled brine. Preserving the fish on board opened a wider range of fishing grounds for tuna purse seining. In sardine and mackerel fishing, most of the catches are still delivered within a period of 6 to 48 hours without freezing. However, several of the larger boats fish sardines during the season and go for tuna the remainder of the year. The brine tanks are often used in sardine fishing to hold the fish in better condition when it is necessary to make a long trip from the fishing grounds and especially on nights when a light sardine catch is made. The fish are then held in a tank of chilled brine while the boat stays on the fishing grounds for a second night of seining before making delivery to the cannery. Use of chilled brine has therefore affected both tuna and sardine fishing success.

Brailing

Two brailing operations are involved in purse seining. One is from the net to the vessel hold and the second is unloading from the hold at a cannery or market dock. There have been no significant improvements in recent years. Standard practice is to employ a long dipper or brailer at sea and a shorter one at the dock.

The "stocking" brail used at sea is planned for speed (Figure 26). It is commonly a five-foot ring suspended by short bridles from a rope running through a block at the boom tip. The slender webbing bag is 20 to 25 feet long and closed at the bottom or far end. From this closed end another line runs through a block at the boom. The pole handle is about the length of the webbing bag. The ring and net are power lifted, swung aboard and the ring placed vertically at the hatch opening (Figure 27). The closed end of the bag is power lifted and the fish poured out through the ring into the hold at the rate of one to three tons per dip or 20 to 40 tons per hour. The handle may be operated from the skiff and its length permits dipping dead or weakened fish from the bottom of the landing bag when there is danger of the net sinking.

FIGURE 26. "Stocking" brail dipping fish from landing bag of the purse seine to the hold of the vessel. Corkline supported by the skiff. Photograph by J. B. Phillips. October, 1941.

The brailer for emptying the boat at the dock is designed for operation in the hold. The ring is smaller, the handle shorter, the bag shorter and the fish are emptied through the far end of the bag by means of small rings and a short purse line (chain). The ring and bag are power lifted by a line through a block at the boom but the purse line is managed by a crew member (Figure 28). At Monterey this brailing from the hold is into a floating hopper connected with the cannery by a suction pipe. Elsewhere fish are dumped into a chute to be taken by elevator to the cannery.

FIGURE 27. "Stocking" brail being emptied through the hoop into the hold of the vessel. Photograph by J. B. Phillips, September, 1945.

Several attempts (at least as early as 1932) have been made at using a suction hose to empty the net at sea but the equipment is expensive and slow. Other trials were made at sucking fish out of the hold at the cannery but the plan was abandoned, although recent attempts are reported as successful. An endless chain bucket conveyor was tried. This could be lowered into and moved about in the hold but was not successful.

FIGURE 28. Purse seine crew brailing from hold to dock. Smaller brail in use. Photograph by J. B. Phillips. September, 1945.

Two Nets

In 1948 a purse seiner tried carrying two nets stacked on the turntable. One was a small seine shorter than the average and built very shallow for hauls close to shore in shoal water. Evidently this trial at handling two nets on one table proved cumbersome. We have not learned whether or not other similar attempts have been made.

There was a period a few years ago when sardine seiners, especially at Monterey, were more than normally plagued by small fish gilling in the nets. This became so serious that many nets were made up with the mesh size reduced to one inch. During this period a few crews tried carrying a small supplemental gill net to be used on a school to determine the size of fish before making a set with the seine.

Tuna bait boats often carry more than one bait net, one for more open water and one for lagoon fishing or shoal water.

Chain Leadline and Purse Bridles

About five years ago (1946) a fisherman tried replacing the leadline of his net by a chain. Although chain costs more than rope, the initial outlay was not too much considering the recent high prices of lead and the chain would last indefinitely. Also, the chain was less apt to catch in the webbing or hang up on the purse bridles. By 1950 a good many purse seines, especially the tuna nets, had foot chains and most net owners were converting to chain as footropes needed renewing. In 1947 one net used a lighter weight chain instead of rope for bridles to the purse rings and by 1950 a dozen or more nets were so equipped (Figure 25).

Depth Finder and Radio Telephone

The first report of a depth finder on a California fishing vessel was about 1927. This was an experimental trial but the instrument was not installed. In the next 10 years the device was adopted by only a few fishing vessels and by 1945 it was in use by only a small part of the fleet. By 1948, however, few purse seiners were without it because it has enabled skippers to locate schools of fish that did not show on the surface. In some cases the depth of the school has been determined by instrument thus aiding the fishing boss to decide whether or not to make a set. Skippers agree that a depth finder has cut down on scouting time and tended to increase their average monthly catches. The development of jack mackerel seining was dependent upon the use of a depth finder and very seldom is a school located by any other means. Instrument locating of schools has been very evident in the lampara bait fishery of Southern California which now depends chiefly upon fish located by depth finder.

The first California trial of radio telephone on a fishing boat is reported to have been in February, 1935, on a Monterey purse seiner. By 1937 these telephones were fairly common in San Francisco and San Pedro and by 1940 they were practically standard equipment in the purse seine fleet. The exchange among skippers of information about fishing conditions has tended to increase the monthly landings of each boat. Especially is this true in the numerous instances when one vessel made an excessive catch and telephoned other boats to come and load up.

Trials with sonar for locating fish have been reported but as yet (1951) these instruments have not contributed to the fishing effort in this State.

Direction finders as aids to navigation have been quite generally adopted by the fishing fleet. Their effect on fishing effort has been indirect except that on foggy nights the boats can move about with greater security.

Strainers and Aprons

Various forms of supplemental webbing for roundhaul nets have been tried but have not been generally adopted. One of the first of these was a strainer used with the lampara nets at Monterey starting in 1921 (Scofield, 1929, p. 35). This was a temporarily attached second sack of larger mesh to strain out the small fish. A portion of the corkline was submerged to allow fish to spill over into the strainer. In the nineteen thirties a supplemental piece of webbing on the leadline of lamparas and ringnets could be pulled across the bottom of the net before it was closed (or pursed). This was to prevent the fish diving under the net before the bottom could be closed. A light purse line through small rings operated this "apron." A similar apron was tried out on purse seines in the nineteen forties but evidently without much success.

It has been common practice to submerge part of the corkline to allow the escape of excess fish when there is danger of their weight splitting the net. In southern waters the tuna seiners provide for the escape of porpoises when they are found in the nets. Sea lions are sometimes induced to leave over the sunken corkline instead of through the webbing which they seem to prefer.

Aerial Scouting

A good many trials have been made at locating fish schools from the air but the results have been discouraging. Often the observer could not distinguish between the kinds of fish seen. At times surface reflection on the water was an obstacle. It is difficult to estimate size of fish from the air. Often the elapsed time was too great between the radioed message and arrival of the fishing boat on the spot. The first trials we have heard of were at San Diego during World War I about 1918. Extensive trials were made in Washington, Oregon and California in the period 1930 to 1938. More recent attempts were made by the tuna bait boats south of our border. The most successful use of a plane has been during the last four or five years in locating basking sharks and schools of white sea bass.

Floating Lights

A school of fish usually is scouted by the skipper before a set is made. The boat may circle the school or cut across it to determine the kind and size of fish, area, depth and density of the school and the direction and speed of movement of the fish. In recent years a depth finder has contributed greatly to this preliminary scouting. For years past an occasional skipper would mark the center of a school by putting overboard a float supporting a lantern to serve as a pivotal point around which to lay out the net. This is not common practice.

Use of a strong light to attract fish at night is an old trick and is often used to catch small fish as bait. An early application in this State was in the Chinese fishery for squid at Monterey more than 60 years ago. A wire basket of burning pitch pine furnished the light. In the last two or three years (Young, 1950) a light has been used by small boats off San Pedro, at first for live bait and later for small scale deliveries to canneries. The latest development is a gasoline engine generator in a skiff powering a strong electric light backed by a reflector low over the water. The light, in combination with use of a depth finder, has greatly increased the catches of these small boats operating a lampara bait net or in some cases a small ringnet. As far as we know, there has been no use in this State, of ultraviolet or "black light" for attracting bait fishes although experiments elsewhere have indicated an increased drawing power of such light.

Powered Net Pullers

In the set line and gill net fisheries of the State mechanical pullers or power gurdies have been in use for the past one or two decades. Vertical catheads cushioned with three automobile tires have been employed extensively in the shark gill net boats. In the last five years similar power gurdies have been tried for pulling in the wings of lampara bait nets. Copying the gill net gurdies, the first trials, about 1947 at Santa Cruz (Phillips, 1951) were with two vertical catheads, one for each net wing. Each skipper made up his own gurdy, usually employing the rear axle assembly from an old automobile. In 1948 a boat at San Clemente (Orange County) was using one large vertical cathead to pull both lampara wings at once. In 1949 and 1950 several boats fishing lamparas for bait were using a more convenient horizontal arrangement of the cathead. It was found that the gurdy would pull a lampara of 150 to 170 fathoms of corkline in about one-half hour (exclusive of brailing)

with a four- or five-man crew whereas hand pulling such a net required about an hour for a six- or eight-man crew. In 1951 a Southern California bait fisherman was very successfully hauling a large lampara 240 fathoms long over a horizontal power puller.

SARDINE PURSE SEINES

Description of a Sardine Purse Seine

Strip Plan. Because of the variation in purse seine construction, we hesitate to speak of a typical net but it may be helpful to describe in some detail an ordinary light purse seine for sardines at San Pedro as of 1950. It was planned to be 260 fathoms around the corkline using webbing on hand supplemented by the purchase of some new webbing of Japanese manufacture. This netting is considered by fishermen to be somewhat inferior in quality to American made webbing but it is less expensive. As it turned out, so much of the old mesh had to be discarded that the final net plan was reduced to 245 fathoms of corkline and 225 fathoms of foot chain. The net plan of five strips with twine weight and mesh size is presented at the top of Figure 29. It will be noted that nearly all the webbing was No. 9 twine and most of it was 1⅛-inch

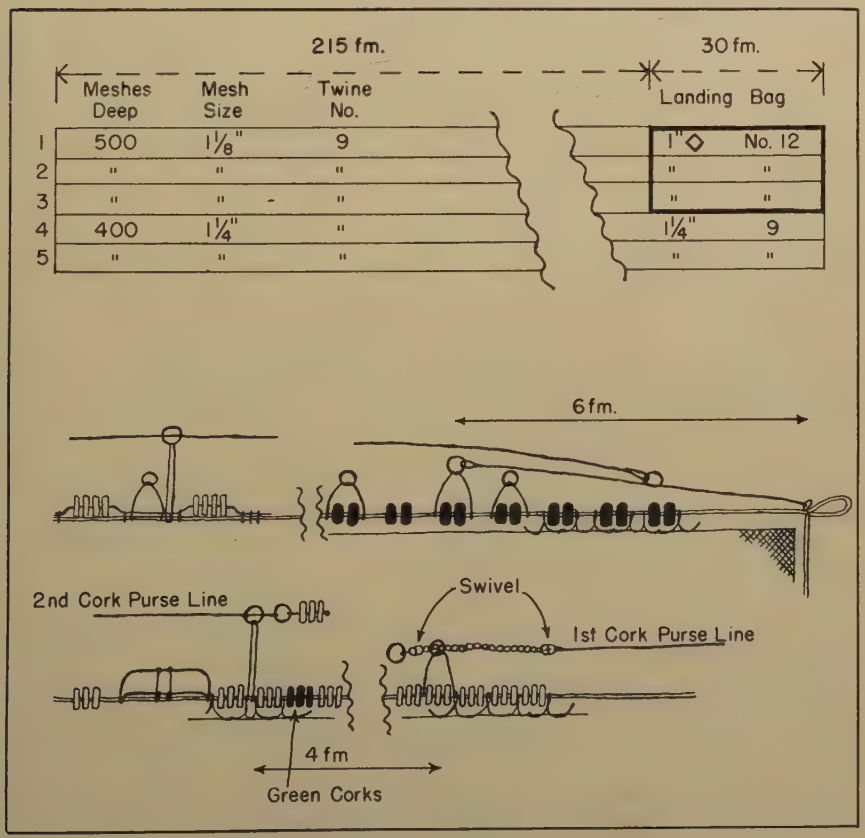

FIGURE 29. Strip plan of a purse seine. Below, corkline detail and cork purse lines indicated. 1950.

mesh for sardines, with the two bottom strips of $1\frac{1}{4}$-inch mesh size. The landing bag was of one-inch mesh of 12-thread twine. This net had no "zipper." The power driven seine skiff carried a powered niggerhead for auxiliary pursing of the corkline.

Selvage. Most purse seines have at the top a narrow strip of $1\frac{1}{2}$ meshes of $3\frac{1}{2}$-inch mesh of heavy twine from No. 84 to No. 120, which is stapled to the cork-line. In this net the twine size was No. 84 at the wing and No. 96 elsewhere. Figure 30 and the upper left corner of Figure 34 indicate this $1\frac{1}{2}$-mesh strip. Laced to this narrow strip is a wider selvage strip which in this net was 12 meshes deep, No. 42 twine and one-inch mesh but $1\frac{1}{4}$-inch at the wing end. This strip was about one foot deep stretched meshes.

Stapled to the foot chain was a wide selvage strip of 25 meshes of No. 84 twine. The large mesh size, $6\frac{1}{2}$ inches, was to facilitate quick pursing of the bottom of the net. The vertical end strip or breast selvage extended from foot chain to headrope (Figure 30). At the bag end of the net this

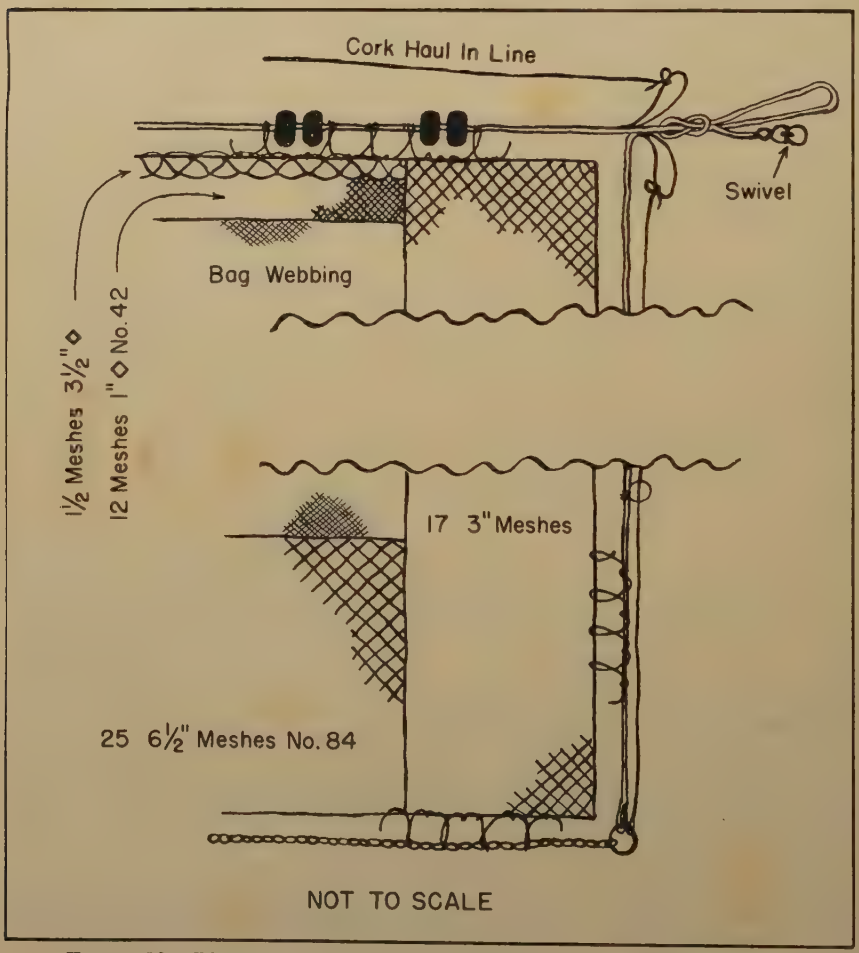

FIGURE 30. Diagram showing selvage strips at bag end of a purse seine.

was 17 meshes (about five feet wide when meshes were open) of three-inch size. The mesh size at the wing end was four inches and the width was 37 meshes. In all the selvage strips, as well as in the five strips of main webbing, the pull with the knots was vertical as placed in the net.

Breast of Net. Each end of the net is called the breast. In this net the 1½-inch headrope was looped at the upper corner of the net, into which was fastened by a reef knot a davit loop three or four feet long. The 1½-inch headrope was continued down the end of the webbing to form the "breast line" onto which the webbing (breast selvage strip) was stapled (Figure 30). At the sack end of the net most of the construction was heavier than at the wing end. At the lower sack corner, the breast line was eyespliced into a 6-inch ring to which was attached also the foot chain and the breast purse line. Spaced every fathom up the breast line were three 5-inch breast rings through which ran the vertical one inch haul up or breast purse line. At the wing end the lower corner ring was five inches instead of six and the breast purse line was ¾-inch rope. At each upper corner there were additional loops or "slings" to which were tied by slip knots the breast purse line, the cork purse line and an additional line for recovering the end of the main purse cable. Other nets have more modern devices for handling the purse wire (Figure 17).

Spliced into the headrope at each upper corner was a towline two or three feet long ending in a heavy swivel. To the sack end swivel was attached the "skiff line" which is passed aboard (after the net is circled) so that the davit loop may be hung on a davit aboard. To the wing end swivel a long tow line or haul line was attached, the free end of which is retained aboard during the circling and is used to haul up the wing and recover the wing davit loop to engage a davit on the port side of the vessel.

Floats. This net employed three kinds of floats, small rubber balls, corks and canvas covered rubber bags. The soft rubber inflated balls suggested small balloon tires. They were seven inches in diameter by 3½ inches thick strung on the 1½-inch manila rope corkline in pairs. They were placed only over the first (from right to left) 20 fathoms of the landing bag (which was 30 fathoms long). In all, there were 46 pairs of balls, the first pair being four feet from the corner of the net. The distance between pairs was one foot for several fathoms with a spacing between pairs gradually increased to 20 inches. A sketch at the right center of Figure 29 represents these floats.

Over the inner 10 fathoms of the landing bag, cork floats were strung on a lighter corkline which was lashed to the heavier 1¼-inch headrope shown at left center of Figure 29. These corks were in bunches of fours, the interval between bunches being 18 inches. Beyond the inner end of the landing bag the double headrope was replaced by a ¾-inch corkline upon which were threaded corks in bunches of three and groups of 12, or sometimes 15. This arrangement of corks was followed throughout the remainder of the net except that most of the corkline was one inch rope instead of ¾-inch. The dimensions of the corks varied from 1¾ to 2½ inches thick by 4¾ to 6 inches diameter but most of them were about 2½ by 6 inches with a ¾-inch or a reamed out one inch hole in the center.

Over the central portion of the net additional floats supplemented the corks. These were rubber bags blown up with a bicycle pump and covered

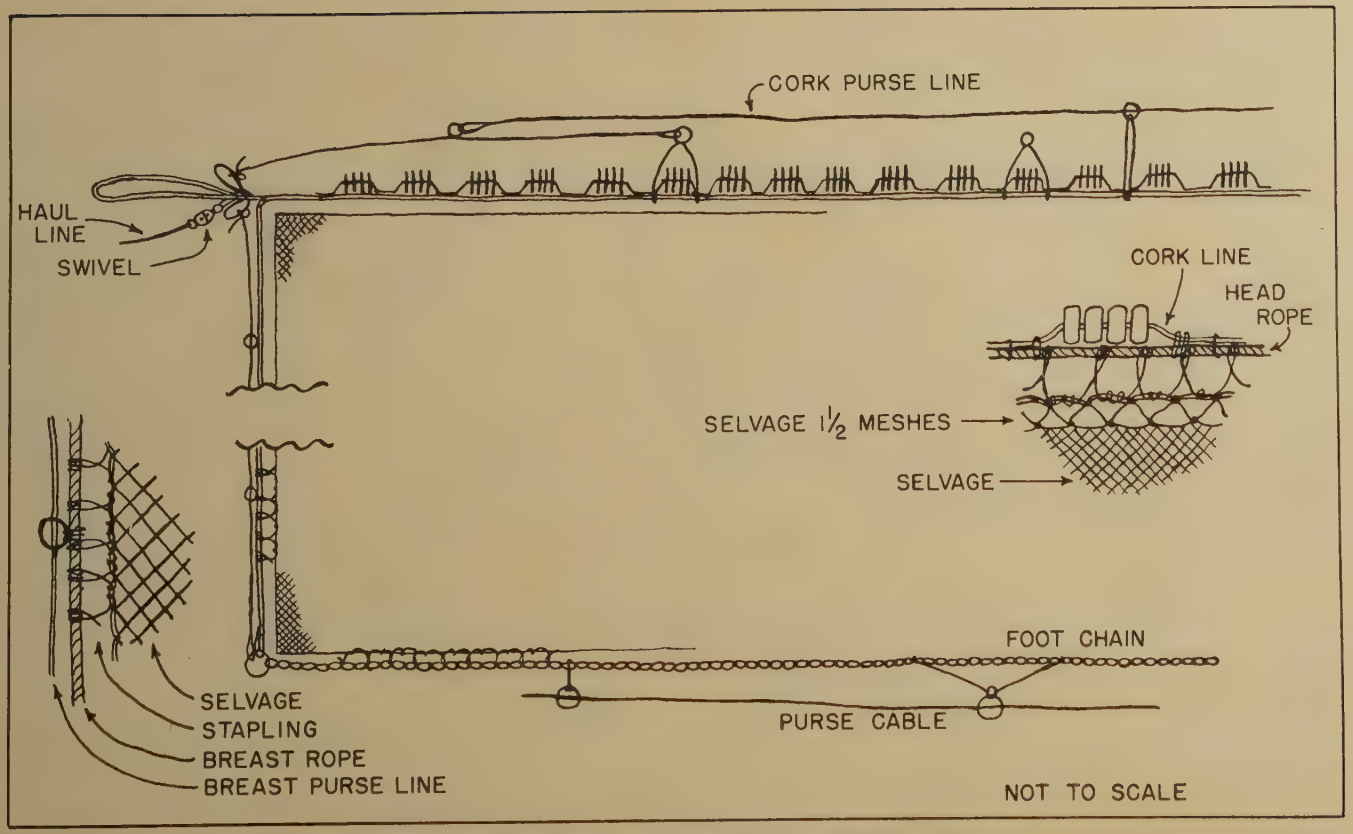

FIGURE 31. Wing end of a purse seine showing cork purse line

by a canvas outer bag 26 inches long by 10 inches in diameter. Bags were lashed to the corkline at each end and in the middle. In all, there were 26 bags spaced two fathoms apart (Figure 29). Many nets employ additional floats that may be snapped onto the corkline when and where needed. Commonly these are inflated heavy rubber balls.

Cork Purse Lines. In this net the corks were bunched by a series of seven cork purse lines, of which the first over the landing bag was about 45 fathoms long and the last one at the wing end of the net was about the same length. The intermediate five lines were a little less than 30 fathoms each. These seven lines of one inch rope were threaded through 6-inch rings which were spaced two and in some cases three fathoms apart and hung to the corkline by 2-, $2\frac{1}{2}$- or in some cases 3-foot bridles that were double but not spread. All along the corkline at either end of any cork purse line the location was designated by painting the corks a bright red, green or white in different combinations of colors to clearly mark the particular spot to facilitate pursing. At the bag corner of the net, the first line attachment to a six fathom secondary line is shown in the sketch of Figure 29. The first line ended in a short piece of light chain swiveled at each end. The chain was supported by a pair of spread 18-inch bridles. Beyond the end of this first line there was a gap of four fathoms before the beginning of the second purse line.

Over the bag end of the net there were additional cork pursing rings and bridles to be used from the skiff by threading a temporary light purse line to support a section of the corkline from the skiff. These auxiliary 5-inch rings were hung to spread bridles that were 12 to 18 inches in length. These small rings were spaced about every four feet over the bag but were more widely spaced further out along the corkline.

After circling the school and picking up the skiff at the bag end of the net, the bottom of the seine is closed by power pulling the purse cable and lifting aboard the bunched purse rings. The corks are bunched at the bow and at the stern of the vessel by power pulling the first and last sections of the cork purse line (each about 45 fathoms long). The other five sections of the cork purse line are pulled from the skiff, usually over the skiff niggerhead but sometimes by hand. Where additional buoyancy of the corkline is needed, the men in the skiff thread temporary short lines through auxiliary rings on the corkline to be supported by the skiff or, in some cases, additional rubber balls are snapped onto the headrope.

Purse Cable. In this net, as in most purse seines, the purse cable was in three sections. The two end sections were each 100 fathoms of $\frac{9}{16}$-inch wire cable and the central section was 50 fathoms of slightly larger wire rope, $\frac{5}{8}$-inch. A swivel was introduced at each point where sections were joined. On board was carried a reserve of nearly 200 fathoms of cable for towline at the wing to allow for miscalculation in circling, drifting and any other contingency that might arise.

Foot Chain. In this net the leadline was removed in September, 1950, and replaced by $\frac{5}{16}$-inch coil chain weighing about seven pounds to the fathom. Nine-inch purse rings were suspended by rope bridles about seven feet long spaced every two fathoms along the chain. An eyesplice at the upper end of each bridle was lashed to the foot chain. A pair of bridles were made fast to a four-inch link supporting the nine-inch purse ring. The distance of the suspended link below the chain was $3\frac{1}{2}$ feet

FIGURE 32. Seine has been pursed and purse rings are bunched at the davit ready to be hoisted aboard. Corkline with rubber ball floats in background. Photograph by J. B. Phillips. September, 1945.

and the link and ring together added another 13 inches. Figure 25 illustrates this arrangement of bridles except that in this net the bridles were rope instead of light chain. Many of the purse seines now (1951) employ chain for both footrope and purse ring bridles. The first pair of bridles was hung four fathoms in from the lower corner of the net under the landing bag. As in most purse seines, the last purse ring $4\frac{1}{2}$ fathoms from the wing end of the net was hung from a single one fathom bridle (Figure 31). The bottom selvage strip of the net was stapled to the foot chain at intervals of six or seven inches with $\frac{5}{3}$-inch tarred manila hanging twine.

Hanging. As mentioned earlier, this net had a corkline of 245 fathoms and a foot chain of 225 fathoms. These figures are approximate. In hanging the webbing to the headrope, $9\frac{1}{3}$ fathoms of netting was hung to 10 fathoms of corkline. This is a take-up of about one foot in 15 or a ratio of about 14 to 15. In hanging the webbing and selvage to the chain there was an allowance of slack of almost 10 percent. Strips of webbing were hung at the seams one to one without take-up. All but the breast selvage strips were hung horizontally so that the pull with the knots was vertical. The square ends of a purse seine are in reality slightly tapered by take-up in hanging to the breast lines. In this net the breast lines, considered as four fathoms were actually 22 feet deep. To the breast line was hung the vertical breast selvage strip which was about six fathoms deep. This take-up was roughly a 1.6 to 1 ratio.

Chafing Gear. Normally roundhaul nets do not employ chafing gear but this particular net had been damaged several times when the wing was being hauled aboard. No projecting rough surface on the vessel could be found so the skipper tried out the plan of protecting the surface of the wing by lacing over it some old $3\frac{1}{2}$-inch webbing. This protecting chafing gear extended inward five fathoms from the wing end and was two strips deep.

FIGURE 33. Crew on turntable stacking the bag end of a purse seine after washing it at sea. Rubber ball float shown on the corkline. Photograph by J. B. Phillips. September, 1945.

Description of Other Seines

A description of a second sardine purse seine is introduced to illustrate the fact that basically these nets are similar in plan but that there is variation in the details of construction and hanging. This sardine net (at San Pedro 1950) was 240 fathoms around the corkline and about 28 to 30 fathoms deep. It was made up of five strips of webbing, each 400 meshes deep. Practically all the strip webbing was $1\frac{1}{8}$-inch mesh. Throughout most of the net the top strip was 12 thread and the other

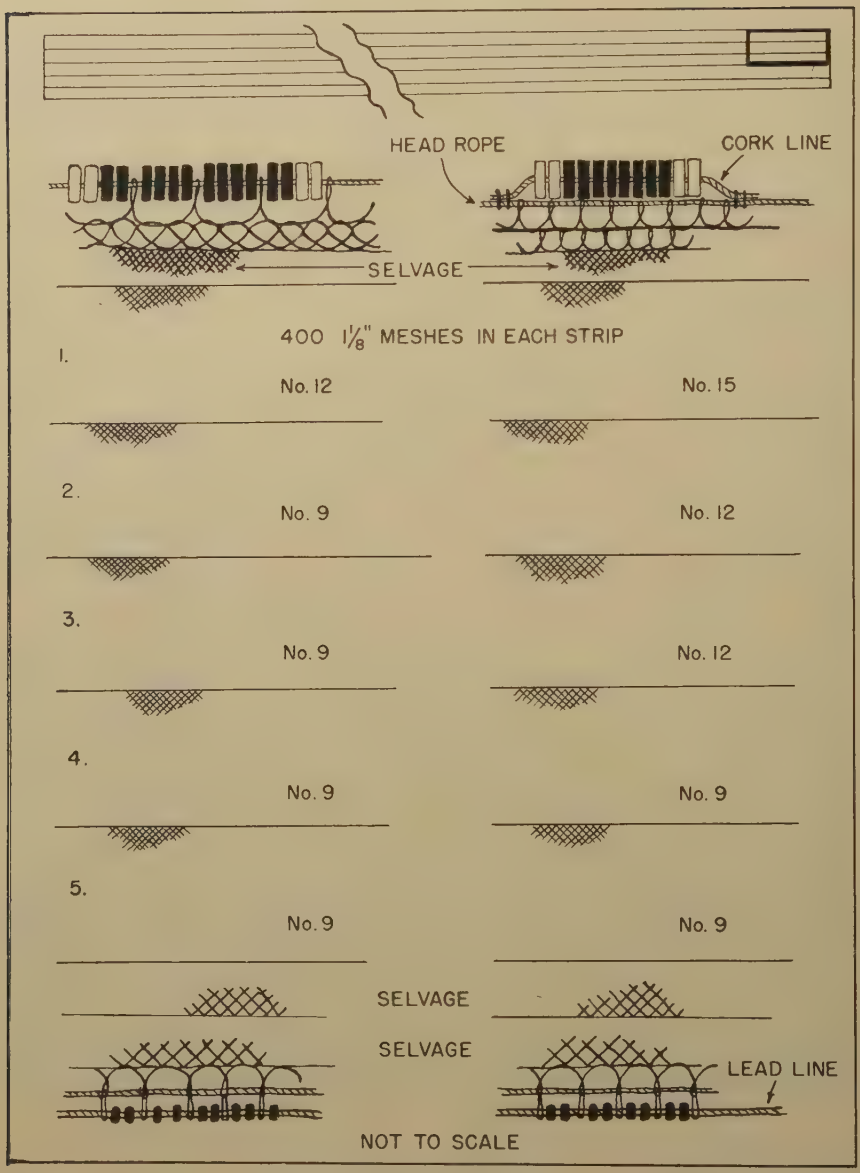

FIGURE 34. Two cross sections through a purse seine to show selvage and webbing strips. Left section through center of the net and right hand section through the landing bag.

four were No. 9. The landing bag, about 30 fathoms long, was three strips deep, the top strip being 15 thread and the second and third each were No. 12. The two strips below the bag were each of nine thread. All strips in the bag were $1\frac{1}{8}$-inch mesh.

At the top of Figure 34 is shown a sketch of the five-strip net plan with the landing bag at the upper right hand corner. Below this are two

cross sections of the net (not drawn to scale) to show the five webbing strips and the selvage. The left hand cross section is at about the center of the net and the right hand section is at one end of the seine through the landing bag.

Over most of the net the corkline was $\frac{3}{4}$-inch manila rope upon which were threaded corks in sets of 16, spaced in groups of fours, with the two outside items of cork and the remainder of foam rubber. As in most seines, there was considerable variation in the arrangement of corks. To the corkline was stapled the usual heavy selvage of $1\frac{1}{2}$ meshes, 120 thread, $3\frac{1}{2}$-inch mesh size. To this $1\frac{1}{2}$-mesh strip was hung a selvage strip of $10\frac{1}{2}$ meshes, 30 thread, $1\frac{1}{2}$-inch mesh size. To this was hung the top strip of main webbing, 400 meshes deep, 12 thread, $1\frac{1}{8}$-inch mesh.

The leadline of $\frac{3}{8}$-inch rope strung with lead weights was hung to a second $\frac{3}{8}$-inch rope by heavy lashing. To this second rope was stapled the bottom selvage strip of 12 meshes of heavy twine and large seven-inch mesh. Above this was a second selvage strip of fifty $4\frac{1}{2}$-inch meshes. To this second selvage was hung the bottom edge of the fifth strip of main webbing of 400 meshes, nine thread, $1\frac{1}{8}$-inch mesh.

Over the landing bag (right hand cross section of Figure 34) the corks, in sets of 12 close spaced floats, were strung on a $\frac{3}{4}$-inch corkline which was lashed to a one inch diameter headrope. To this headrope was stapled a 5/16-inch rope to which, in turn, was stapled the upper edge of the corkline selvage strip. Over the bag, this selvage strip was 16 meshes of 30 thread $1\frac{1}{4}$-inch mesh. This strip corresponded in depth to the $10\frac{1}{2}$ meshes of $1\frac{1}{2}$-inch mesh size in the selvage strip along the remainder of the net. The double stapling (to the one-inch headrope and the 5/16-inch secondary rope) was done with heavy 5/16-inch rope.

In this net the five strips of webbing and all the horizontal selvage strips were hung so that the pull with the knots was vertical. Wire cable was used for purse line through seven-inch rings on one fathom rope bridles. The cork purse lines ran through five-inch rings supported on 18-inch double bridles.

Brief notes on a third sardine purse seine include minor variations but illustrate a common type of seine with square bag end and tapering wing end. There was no zipper. The purse line and the corkline were $1\frac{1}{4}$-inch rope. Webbing was $1\frac{1}{8}$-inch mesh. The leadline was two half-inch ropes, the upper carrying the leads and the lower free of weights, the two being lashed together by stapling every eight inches. The purse rope at the bag end ran up to a spring shackle engaging a link in the line. The breast purse line was eyespliced to the breast line at a point two fathoms above the lower corner of the net. The tapering wing end had six or seven fathoms of very heavy five-inch selvage.

Small boats fishing sardines with a seven- or eight-man crew are commonly called baby purse seiners. The nets are under 200 fathoms, usually have tapered ends and sometimes are tanned instead of tarred for ease in handling. Often the net is operated without a turntable. The method of stacking the net may be modified to accommodate it to installations on the limited space of the after deck. One such baby net examined in 1950 on a 40-foot boat was 165 fathoms long with a landing bag at one end 15 fathoms long. There was no turntable. A davit was lacking but a heavy bit aft of the house served instead. The two piece purse line was

of $1\frac{1}{2}$-inch rope. The crew was eight men. Mesh size was $1\frac{1}{8}$ inches for sardines. The main webbing was four strips, each 400 meshes deep.

A few fishermen have a special mackerel purse seine of two-inch mesh but the great majority of crews fish sardines or mackerel with the same net without alteration of the seine.

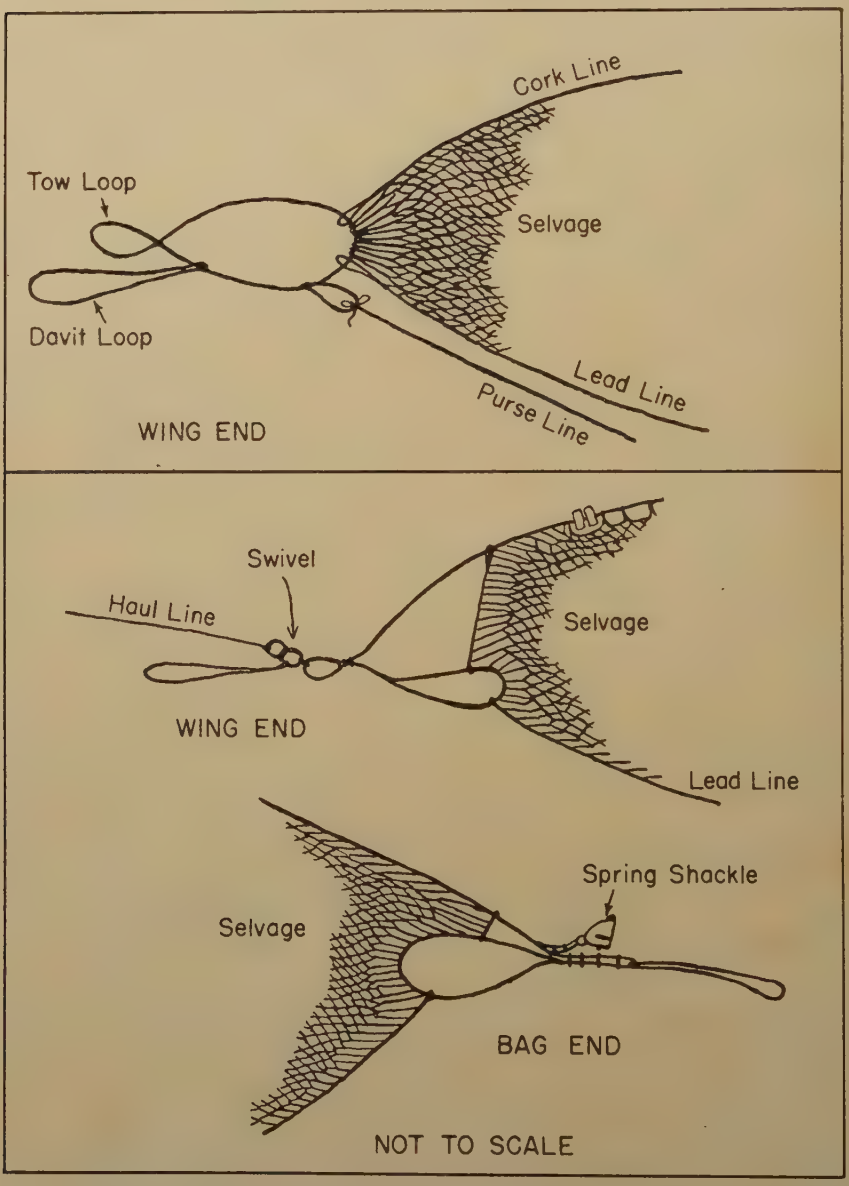

FIGURE 35. Variation in seine ends. Upper sketch shows wing end of a sardine purse seine. Lower sketch shows wing and bag ends of a tuna purse seine.

TUNA PURSE SEINES

The tunas are not found in such compact schools as are the sardines or mackerel and most tunas are large heavy fish. Tuna purse seines are therefore longer, of heavier webbing and of larger sized mesh than are used for sardines. Whereas sardine nets are generally 200 to 300 fathoms long, the tuna seines range in length from 275 to 350 fathoms and are usually deeper in proportion. Many are approximately 10 percent of the corkline in depth. The twine size in tuna webbing is No. 36, 48 or even 72 with 42 as a possible average. Selvage strips may be No. 96. Mesh size is usually $4\frac{1}{2}$ inches. In some cases it may be as high as seven inches which is satisfactory for large tunas but is apt to gill small skipjack.

The tuna seines are built after the same plan as sardine nets except that they are larger and heavier. There are one or two extra strips of main webbing to reach greater depth. All lines, rings, selvage and other accessories are necessarily stronger. Many tuna nets have tapered ends. Sections of wire cable are used more than in sardine nets, especially as reinforced ends of the seine. It is not uncommon to see cable headline, davit loops and an open wire loop to which the webbing of a tapering end is lashed by hand-woven large meshes of selvage. A woven base for this selvage may be a few meshes of $\frac{1}{2}$-inch rope. Foot chains and purse bridles of chain are common. The strain of hauling and pursing the larger area of webbing in the water is much greater than for sardine nets in spite of the larger mesh size in tuna seines.

Brief descriptive notes on a couple of tuna purse seines will illustrate differences between tuna and sardine nets. One tuna seine examined in 1947 was 350 fathoms on the corkline which was of $1\frac{1}{4}$-inch rope. The leadline was rope instead of chain. Nine-inch rings were spaced five fathoms apart along the footrope. Corks were pursed by lines through five-inch rings closely spaced and hung to the headrope by 40-inch single bridles. Floats were corks with a large proportion of seven-inch inflated "balloon tires" of rubber in groups of threes with a one-foot space between groups. Cork floats were $5\frac{1}{2}$ inches diameter by 2 inches thick. This net obviously was intended for large tunas as most of the webbing was six-inch wesh of No. 72 thread twine. There was no zipper.

Another tuna purse seine (San Pedro, October 1950) was made up of four-inch webbing throughout. Corkline selvage was five-inch mesh and over the leadline the selvage was $7\frac{1}{2}$-inch mesh. The net had tapered ends. At the wing end there was a $\frac{1}{2}$-inch cable headrope for six fathoms and at the bag end the cable extended over the landing bag. Stapling to the cable portions of the corkline was by $\frac{1}{2}$-inch rope and lighter rope staples were used on other portions of the corkline and on the leadline. This net employed a large proportion of foam rubber corks and they were strung on the cable portions, as well as the rope sections of the headrope. Corks were in groups of 10, 12 and 14. The leadline was rope. This net had a zipper with five-inch rings. At each end of the seine there were a few meshes of hand-woven $\frac{1}{2}$-inch rope to which was laced very heavy selvage of $4\frac{3}{4}$-inch mesh. The davit loops were of cable and the bag end was provided with a spring shackle. The net ends are illustrated by sketches in Figure 35.

WHITE SEA BASS PURSE SEINES

Although purse seining of yellowtail, barracuda and white sea bass is now prohibited by California law, a few boats net these species in the waters off Mexico. One such net examined in 1950 had 220 fathoms of corkline and was operated without a turntable. The webbing had been $2\frac{1}{2}$-inch mesh but had shrunk to two inches from tarring. Twine was 21 thread. There was no zipper. Both net ends were square. The purse line was $1\frac{1}{4}$-inch rope, cork purse lines were $\frac{3}{4}$-inch and the footrope carried leads. Breast lines were pursed in the usual manner except that the wing end breast purse line was spliced in at a point one-half fathom above the lower corner of the net. Breast selvage strips were about four fathoms wide of four-inch mesh. The only corkline selvage was the common $1\frac{1}{2}$ meshes of 96 twine. The leadline selvage was 50 meshes of $4\frac{1}{2}$-inch mesh of 42 twine, the upper edge of which was not laced to the main webbing but to a quarter-inch rope which ran the entire length of the net from breast line to breast line, even through the vertical strips of breast selvage. To this rope was laced the lower edge of the main webbing.

RINGNETS

By definition, the ringnet, like its lampara ancestor, is hauled in by pulling aboard the two wings simultaneously. This method of hauling is being abandoned for the practice of "strapping in" one wing by use of power winch and the ship's boom. Many nets now have two landing bags, one of which is in the center of the corkline, but even in such cases, the net is pulled with the boom by one wing. The hand pulling of both wings at once is disappearing so rapidly that it is now (1950) possible to find only a scattered few of the typical ringnets hand pulled over the stern, the two ends simultaneously. The desirability of distinguishing between ringnets and purse seines is therefore becoming less and if the present trend continues, the typical ringnet will survive only as an oddity.

When purse seines were pulled by hand, the lighter ringnets could be handled by a somewhat smaller crew but in these days of power pulling the situation is reversed. A hand pulled ringnet requires 12 or more men whereas a similar sized purse seine can be handled by 10 men aided by the power winch.

The ringnet has some advantages. It is lighter to handle, cheaper to build and is considerably faster than a purse seine. A ringnet haul (exclusive of brailing) may be made in about one hour but the usual purse seine haul requires one and a half to nearly two hours. With a ringnet the crew can and usually does make more hauls per night, which is particularly desirable on nights when fish schools are small and scattered.

A fundamental handicap to any net pulled both ends at once is the necessity of restacking one wing to be ready for the next layout. In the purse seine method, after the circle, pulling in first the last wing to go overboard allows stacking this wing on the bottom of the pile during the hauling operation. The bag end of a purse seine is first in the water but comes aboard last so that it is on top of the pile ready for another layout without restacking. In ringnets and lamparas, both wings come in together with the central bag last. One wing must be repiled before the net is in shape to be circled again. In a counterclockwise layout the right

wing is stacked while being pulled but the left wing is in a temporary pile and must be reversed by restacking before the next circling.

The method of stacking the net on the stern of the vessel helps the observer to recognize the ringnet. Purse seines commonly are stacked with the corks fore and aft along the starboard rail and the leadline and purse rings along the port rail, assuming the normal counterclockwise layout. Most, but not all are on a turntable. A ringnet is stacked with the corks athwartships, the purse rings on the port quarter close to the stern. The ringnet davit is at the center of the stern rail while the purse seine davit is located on the port rail near the winch. The ringnet is operated without a turntable. Both wings of a typical ringnet are tapered.

Present day ringnets are built of lighter weight materials than are purse seines. The webbing is of lighter thread requiring less floats on the headrope and lighter bridles and purse rings on the footrope. Other accessories are correspondingly lighter weight. The ringnets are, in general, about two-thirds the over-all size of other sardine seines and few exceed 200 fathoms of corkline.

Because of the pulling of a ringnet by the two wings, there is a somewhat more noticeable horizontal strain on the webbing of the wings. For this reason builders of ringnets run the wing strips vertically so that the pull with the knots will be horizontal. This is not a consistent difference between the two nets but vertical strips are found more frequently in ringnets than in purse seines.

BAIT NETS

Practically all the bait nets are lamparas, that is, without purse line, with a prominent deep bunt in the center and sharply tapering wings of larger mesh size. There is a considerable range of sizes as measured by length of corkline. Nets used by a fisherman to supply bait to his own boat may be as small as 120 fathoms. One lampara handled by a power puller measures 240 fathoms but a bait net as large as 200 fathoms is exceptional. The normal size range is from 135 to 170 fathoms. The normal proportion of bunt to total length is about one-fifth. Each wing is roughly two-fifths of the corkline. The chief characteristic of the lampara is a deep scoop-shaped bunt of small mesh. Below this bunt, between the small mesh and the leadline, is an area of larger mesh called the bed, floor, or sometimes throat or apron. Skillful hanging of this floor not only adds to the fullness of the bunt but its larger mesh permits it to be pulled upward more quickly than the small mesh of the bunt. This serves to check escapement of fish under the net till the leadline is pulled parallel to close the bottom of the net. As a result of this method of closing the net bottom, the lamparas do not fish as deeply as other roundhauls of comparable size. Below the center of the corkline is an area of heavier twine, called the landing bag, where the catch is concentrated (dried up) and from which the fish are brailed into the boat (Figure 36). In these small nets there are comparatively few corks on the headrope and widely spaced leads on the footropes. The wing ends are a rope loop rather than a spreader stick (brail) as in the large lamparas. There are selvage strips along cork and leadlines and sometimes at the base of each wing where it joins the bunt. The wings are not detachable from the bunt as was true of many lamparas of past years.

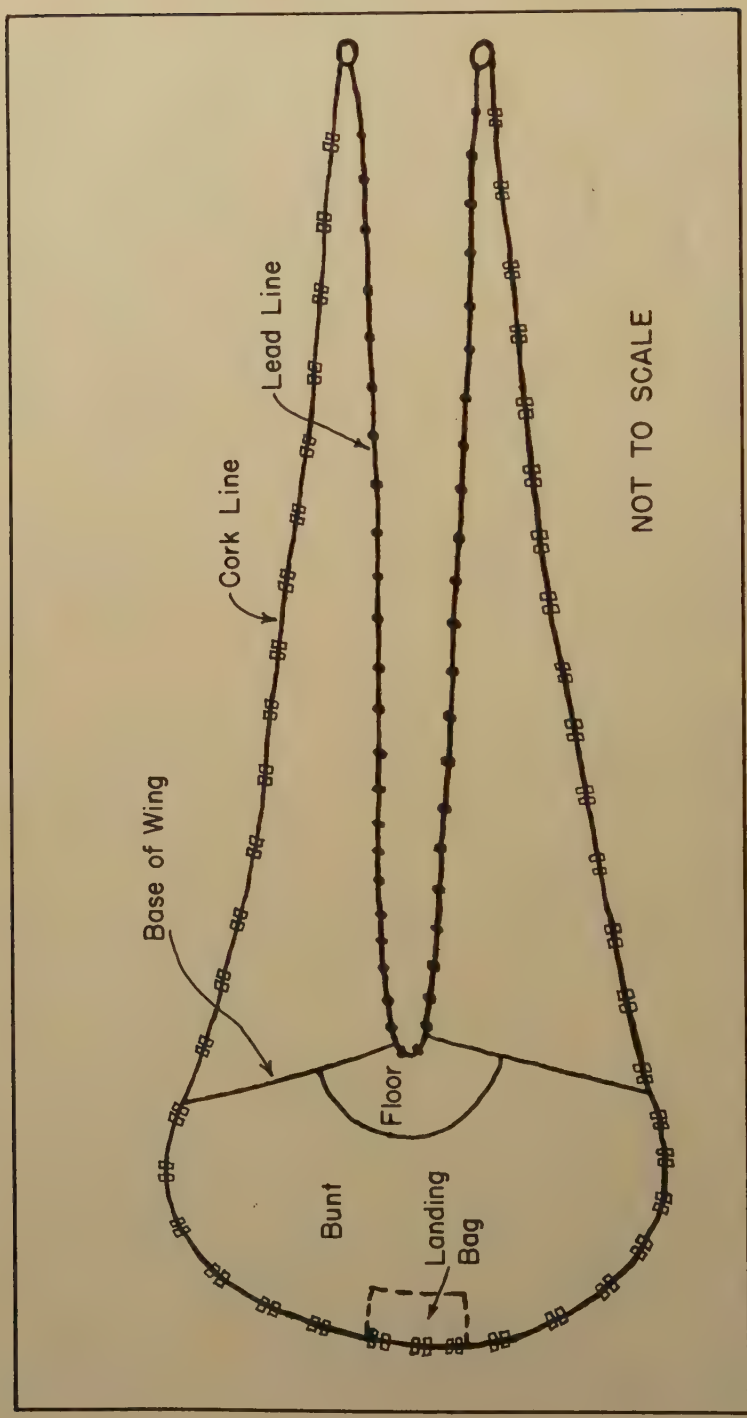

FIGURE 36. Outline sketch of a lampara bait net as spread to dry

A small lampara used to supply bait to one boat was constructed as follows: The total length of corkline was 135 fathoms, the corkline over the bunt was 25 fathoms. The mesh of the bunt was ½-inch of No. 6 twine. The floor webbing was light weight 3¼-inch. The base of each wing was three-inch mesh but the main webbing of the wings was six-inch of nine thread. Over the bunt was a corkline selvage of three meshes, 1½-inch. The leadline selvage was comparatively heavy 3½-inch mesh. There were meshes of 1½-inch selvage at the base of each wing and along the leadline. Corkline selvage was 18 meshes of three-inch. Lead and corklines were ½-inch rope. The floats were pairs of 3½-inch corks, 18 inches between pairs.

FIGURE 37. Small purse seiner, without turntable, in a partially completed haul for squid at Monterey. Photograph by J. B. Phillips. May, 1946.

A larger bait lampara had 160 fathoms of corkline with ½-inch mesh of six thread in the bunt and the wings were of uniform mesh size, eight-inch of nine thread. The floor was four-inch six thread. Corkline selvage over the bunt was three meshes of 1¼-inch nine thread and over the wings four-inch nine thread. In this net, as in most larger lamparas, the webbing strips of the floor and the wings were hung vertically so the pull with the knots would be horizontal. In the bunt the horizontal strips would give a vertical pull with the knots.

A Santa Cruz lampara as described by Phillips (1951) had 172 fathoms of corkline, each wing of 65 fathoms and was 42 fathoms deep at the bunt. Wings were eight-inch nine thread. The bunt was ¾-inch six thread. The floor was four-inch nine thread and the landing bag was one-inch nine thread.

Tuna bait boats often carry more than two bait nets not only to have spare nets but also because bait fishing conditions differ widely according to locality. There may be sandy beach, open sea, shallow lagoon or even rocky bottom. In the latter case crew members dive over side to nurse in the leadline over the sharp snags. Live bait means the difference between profit or loss for the trip. Some tuna boats carry four or five nets of three or four types to be ready for taking bait whatever the conditions. The lampara bait net, ranging in size from 80 up to 140 fathoms long, is standard equipment.

In past years a small and shallow ringnet was sometimes carried for open sea hauls and it could, in emergency, be used as a beach seine but at present only lamparas are carried. The bait nets for sardines are usually 130 fathoms long with half-inch mesh in the bunt and six-inch mesh in the wings. A net for anchovettas is a little smaller (120 fathoms long) with one-inch mesh in the bunt and six-inch wing mesh. For the Galapagos Islands a small lampara of 80-fathom corkline and very short wings is used. This has a mesh size of $\frac{3}{4}$-inch in the bunt and the wing mesh may be only one inch. In tuna boat bait fishing, the net is usually operated from a seine skiff towed by a small power boat. A smaller second skiff tows behind. After the catch is dried up in the net the tuna vessel comes alongside if there is sufficient depth of water or the net is towed to the vessel if necessary and the catch is transferred into the live tanks aboard by dip nets called scoops.

LEGISLATION

Through the years California law governing the use of roundhaul nets has had many changes but the trend has been toward more restriction. The chief curtailment has been the closing of certain areas to roundhauls. A secondary curtailment has been the establishment of seasons closed to roundhauling in certain areas. A third restriction has been laws prohibiting the taking of certain species of fish by roundhaul. There have been a few instances of a minimum size limit for some species of fish taken in roundhaul seines. There has been only minor regulation of the size of mesh in these nets. With the exception of bait nets, there have been no restrictions as to the type of construction or weight of webbing or the method of operating roundhauls. Several times legislation to limit the size of nets has been urged but in nearly every case, except in bait nets, this rather futile method of curtailment has been avoided. What is probably the most effective restriction has not as yet been applied in California, that is, the direct limitation of total catch by the establishment of boat catch limits or regional or state-wide bag limits for a season.

It is not the intention here to detail all the minor legal changes in this State but the more important restrictions will be mentioned. At times some of the laws have been confusing because of the rather peculiar terminology used in drafting the law but the real difficulty has been the lack of standardized names for fishing gear and the fact that both the gear and the names have been subject to change through the years.

There is one unusual feature of fishing gear legislation in California. A law passed in 1917 provided that all gear was illegal unless specifically permitted. Our gear laws therefore state where, when and how each type of gear may be used. All else is illegal. This eliminates "Thou shalt not"

but the final result is the same and in the following pages it seems natural to explain what was prohibited rather than what was permitted. The purpose of the 1917 law was to forbid new gear or new combinations of gear or methods of operating until the new devices could be reviewed by the Legislature. In practice, this provision has had surprisingly little detrimental effect in discouraging invention of new gear and methods.

The early gear laws of this State made no mention of roundhaul nets although some existing laws indirectly affected them. For example, the laws of 1909 did not specify purse seines but no seines or traps could be used in tidewater of Mendocino County. Certain areas were closed to all nets but these restrictions were of minor consequence.

The most important early law mentioning roundhaul nets was that of 1915 which statute established the principle of forbidding gear (in this case only roundhauls) except as specifically permitted. This principle was later enacted as a separate section of the code (636) in the law of 1917 and applied to all gear, not just roundhauls. The 1915 law prohibited the use of purse seines, circle seine or lampara to take fish, shellfish, shrimp, or crabs in the State except that these nets might be used in certain specified districts. Actually most of the coast was open to these nets. Del Norte and Humboldt Counties, a portion of Monterey Bay, all of Santa Catalina Island and most of the inland waters were closed to roundhauls. The language of the law referring to operating these nets was "Every person who shall cast, extend, use or continue, or shall assist in casting, extending, using or continuing any circle seine—" etc.

The 1917 law prohibited all gear to take fish, mollusks or crustaceans "except as hereinafter provided." Del Norte and Humboldt Counties were opened except that in one district (6) purse seines were not allowed to take salmon or steelhead. The waters of Santa Catalina Island were made into two districts, in one of which (20A) roundhaul bait nets could be used for anchovies or sardines for bait only.

The 1919 law made only minor district changes. In one small section (7A) off the Humbolt County coast there was an open season (April 1st-July 31st) and a minimum mesh size of one inch for circle seines or roundhauls "taking smelt, herring, perch, sardines or other nongame fish." Purse or roundhaul nets were not to be used in any district "for the purpose of taking salmon, steelhead, striped bass or shad." The nets could be used in a portion of the waters off Santa Catalina Island.

In 1921 there was little change. In two Sacramento River districts (12 and 12A) any beach seine, purse or roundhaul net found in any fishing boat was prima facie evidence of use in the district. Two years later the South San Francisco Bay district (13) was added.

The law of 1923 made no important change in roundhaul fishing. Apparently up to this time there was no special legislation governing the so-called "whitefish"—barracuda, white sea bass and yellowtail.

The 1925 law added barracuda to the list of species (salmon, steelhead, striped bass and shad) which could not legally be taken in purse or roundhaul nets anywhere in the State. This was in effect but two years.

A feature of the 1927 law was the establishment of a closed season (May 16th-July 31st) for roundhauling barracuda in all districts. It was unlawful to possess barracuda on a roundhaul boat during the closed season.

There was no significant change in 1929. The closed season for netting barracuda was changed to May 1st-July 31st.

In 1931 there was established the Santa Monica Bay district, 19A in which roundhaul nets could be used to take live bait only. The size of bait net in District 19A was limited to 120 fathoms along the corkline and 10 fathoms in depth (Section 926). This net size limit remained in effect 14 years until omitted from the code in 1945. There was a provision that roundhaul boats with net aboard could cross or enter closed districts (Santa Monica Bay and part of Santa Catalina Island) in emergency or distress. Later this led to much quibbling in the courts.

The 1933 law (in effect October 25th) declared it unlawful to use any net to take yellowtail between June 1st and August 31st, or to sell net caught yellowtail during this closed season. Canning of local yellowtail was prohibited, but imports from south of the international boundary could be canned. This canning restriction remained in effect until June, 1940. A two-month summer closed season (May 1st-June 30th) on roundhauled barracuda and white sea bass was established (Section 868).

The 1935 law established a uniform four-month summer closed season (May 1st-August 31st) on using any net to take barracuda, white sea bass and yellowtail (Section 868). This closed season remained in effect until 1941. The 1935 law (Section 844) closed the Orange County coast to all nets to a distance of two miles out from shore. This enactment was rendered invalid by court decisions so that it was in effect only for a few months although the statute was carried in the code for several years.

The 1937 law defined bait net (Section 919) as a lampara or roundhaul type of net not exceeding in strength No. 6 medium laid cotton seine twine (a three-foot No. 9 selvage along the corkline was permitted) with no rings along the leadline or other method of pursing the bottom of the net. This requirement was intended to prevent the catching of barracuda, white sea bass and yellowtail under the pretense of fishing live bait.

In 1939 there was one important change in roundhaul curtailment (Section 929), in that these nets could not be operated inside a two-mile area off the coasts of San Luis Obispo and Santa Barbara Counties.

Section 868 of the 1941 law extended the four-month closed season by prohibiting the taking or possession of roundhauled barracuda, white sea bass or yellowtail at any time except that these fish could be brought in from south of the international boundary (Section 867) under certain regulations. This went into effect in June of 1940 as an emergency measure at the 1940 Special Session and continues to the present (1951). Bait nets were excluded from most of the area around Santa Catalina Island (District 20, Section 919) and this provision remains (1951).

Other restrictions continued, such as the bait net strength of twine (Section 919), and the prohibition against roundhauling salmon, steelhead, striped bass or shad (Section 928). In the next four sessions of the Legislature (1943-1949) there were no important changes affecting roundhaul nets.

The legislation of 1951 added another area closed to purse seines and ringnets but it did not include lamparas and bait nets. This was an emergency measure going into effect the latter part of June, 1951. The Orange County coast out three miles from shore was closed Saturdays and Sundays for four and a third months (May 1st to September 10th). Within

this area, three portions were closed to the *two*-mile limit every day during the four and a third months. These three portions were a two-mile radius about Dana Point, San Mateo Point and a six-mile stretch of coast south from the mouth of the Santa Ana River. The 1951 legislation, effective September 22, 1951, modified three other closed areas. Bait nets were prohibited in District 15 during the sardine season. This district is off the City of Santa Cruz on Monterey Bay out to the 10-fathom contour. All types of roundhaul nets were permitted in portions of District 16 for squid only from June 1st to August 31st. This district is the cove in front of the City of Monterey. The area two miles out from San Luis Obispo and Santa Barbara Counties had been closed to all kinds of roundhaul nets, but the 1951 law opened the district except that small areas around certain piers remained closed to all nets.

As of 1951, most of the ocean waters from Oregon to Mexico are open to roundhaul nets. There are several small closed areas, but only three closures are of much importance. These are District 20 (a portion of Santa Catalina Island waters), partial closure of the Orange County coast and District 19A (Santa Monica Bay). In state waters, roundhauls may not be used to take a number of species of fish, chief of which are salmon, steelhead, striped bass, shad, yellowtail, barracuda, white sea bass and most other crokers.

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